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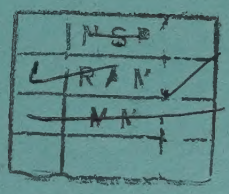

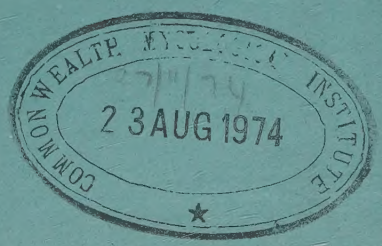

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INTRODUCTION

At the request of the Kenya Government, two FAO soil scientists visited the country to advise and recommend on the system and methods to be used in collating all existing soil survey material so that it can be used as a basis for a subsequent country-wide survey. At the same time a team of three soil scientists from the Netherlands were carrying out a feasibility study for the establishment of a Kenya soil survey unit.

The crop products quality laboratory reports results on quality assessment of copra dried to different moisture levels, influence of fertilizers on the quality of citrus fruits and the effect of storage period on the quality of macadamia nuts.

Prolonged heavy rains and cool weather conditions during the first half of the year favoured widespread occurrence of plant diseases. Twenty new records of fungi and bacteria were added to the Kenya Host List of Fungi and Bacteria.

The programme of research into the ecology of the rat pest species, begun in December 1969, was continued with the object of determining the causes of rat outbreaks. If the causes were known, outbreaks might be predicted and some means of preventing them ultimately devised.

To facilitate bulk handling of grains, numerous trials were completed with both road and rail transport.

In 1970, plans were drawn up to extend maize agronomy research to the other main maize growing areas of Kenya where little agronomic research had been done in the past. A formal request for assistance in this Maize Agronomy Project was submitted to the U.K. Government.

Variety trials in sunflower were carried out for a second year in 1970 mainly to compare the improvement in seed yield of crosses between local and exotic plants versus top Kenya sunflower varieties. Additionally, other important agronomic factors such as oil percentage in seed and total oil production per ha. were studied.

At the Plant Breeding Station, Njoro, one new bread wheat variety named Twiga was released in 1970. The same station tested 20 varieties of flax and 10 of rapeseed at three locations. These varieties grew well and produced good yields. It should be possible to produce rapeseed oil locally to help replace the large quantity of edible oils now imported.

Other experimental results of interest are from the horticultural, sugar-cane and pyrethrum research stations.

J. J. NJOROGE,
Chief Research Officer.

NATIONAL AGRICULTURAL LABORATORIES, KABETE

I—SOILS AND AGRICULTURAL CHEMISTRY

SOIL SURVEY.—N. N. NYANDAT, O. OSWAGGO, D. O. MICHIEKA

Two F.A.O. soil scientists visited the country at the request of the Kenya Government. These were later joined by three soil scientists from the Netherlands. While the former team had been requested to advise and recommend to the Government on the system and methods to be used in collating, as far as possible, all existing soil survey material so that this may be used as a basis for a subsequent countrywide soil survey, the Netherlands team came to carry out a feasibility study to assess our needs for soil surveys particularly in relation with a technical assistance application that had been made to the Netherlands in this connection. The two teams prepared reports which have been valuable to the Ministry in the final preparation of the application for technical assistance to finance the expansion of the soil survey activities of the Research Division.

During the year, seven areas were surveyed for development projects. These were as follows:—

Salim Road Investment Scheme, Coast Province—N. N. Nyandat and O. Oswaggo

Arising from the likelihood of finding overseas market for cassava an intensification of cassava production at the coast was contemplated. A pilot and nucleus scheme of some 2,400 hectares was proposed. A soil survey was accordingly commissioned to determine the suitability of land for the intended development. The investigation revealed that only 208 hectares consisting of sandy loams and sandy clay loams were suitable for cassava production. The rest of the land amounting to 1,536 hectares had shallow soils. A further 656 hectares consisting of high cracking grey clays was considered unsuitable. On the whole arable agriculture on this land is limited by the extremely broken and uneven topography.

Ishiara Irigation Scheme, Eastern Province—N. N. Nyandat and O. Oswaggo

The scheme lies immediately north-east of Ishiara Market on the Embu-Meru road. It was set up in 1955 on 29.6 hectares of land owned by 37 tenants. It is proposed to expand the scheme to 110 hectares. A soil survey was conducted to look into the possibility of finding additional land suitable for irrigation and also to constitute a basis for organizing efficient management of the existing scheme.

The report outlines five soil units. The soils are deep in some areas and stony in others. Arable patches consist of dark brown clays underlain by yellowish red medium clays. There are also some two hectares of swamp affected soils which at present show strong tendency towards salinity and alkalinity. This latter area will require interception drains to guard against the brack spreading to the adjoining areas of the scheme. Out of the 110 hectares (including the existing scheme) surveyed, only 66 hectares were found suitable for irrigation agriculture.

Limuru Potato Research Farm, Central Province—N.N.N. and O.O.

A soil map for 72 hectares of the Limuru Potato Research Farm was completed on a scale of 1:1250. The soils consist of deep reddish brown clays and appear fairly uniform with variants arising only from steep slopes. The soil pH ranges from 5.0-6.3 for top soil and 4.3-6.7 for subsoil with a tendency to strong acidity in the steep areas.

Mwea Cotton Research Station, Central Province—D. O. Michieka and O.O.

Eighty-four hectares of the Mwea Irrigation Scheme (Tebere Unit 12) were surveyed for the siting of a cotton research station on a scale of 1:2500. Nine soils were delineated. These range from deep well drained dark reddish brown clays through

stony well drained clays to poorly drained grey heavy clays. A greater part of the station (64 hectares) consists of deep well drained reddish brown clays. Stony areas total about 2.5 hectares. The rest include areas with seasonal swamps and impeded drainage whose clay mineral is predominantly montmorillonite.

Faculty of Agriculture Farm, Nairobi—N.N.N. and O.O.

The farm is situated at Upper Kabete and by computation consist of 259 hectares. At the time of survey it carried cultivations of coffee, napier grass and timber. A detailed survey was carried out to determine the soils of the farm and their chemical and physical status with a view to the siting of future experiments and provide information for farm management in general.

Eight soil phases arising from conditions imposed by slopes, soil depth and drainage were delineated on a scale of 1:2850. The deep and shallow well drained soils consist of reddish brown clays underlain by dark red clays. Soils with seasonal high water table and those with impeded drainage consist of dark brown to grey brown clays. Montmorillonitic clays predominate in the latter group whereas kaolinitic clays (possibly metahalloysite) predominate in the well drained soils. Soil fertility is very variable over the farm. Both conditions of extreme deficiencies and high level of nutrients were encountered.

Ramisi Sugar Estate, Coast Province—N.N.N. and O.O.

The Ramisi Sugar Estates consist of six sections namely Gazi, Famoni, Kuromojo, Kanana, Kiwambale and Mrima. The total area surveyed was approximately 4,800 hectares. There exists a marked variation in sugarcane yields not only between sections but also within the sections. A semi-detailed survey was undertaken to outline the major soils of the estates and to look into the major soil problems.

The major soil problems were observed to arise from poor drainage, low water retention capacity, seasonal high water table, nutrient deficiencies and variable soil depths. Another clear noticeable problem was the occurrence of sugar-cane scales. Soil map and report for the area will be completed early next year.

Kaputir Agricultural Development Scheme (Turkana), Rift Valley Province—O. Oswaggo

Kaputir Agricultural Development Scheme lies on the west bank of the Turkwell River in Turkana District. The scheme was started in 1968 and is aimed at settling some nomads in permanent dwelling. The tenants will be taught simple agricultural methods. At the time of the survey the camp had a population of 230. About 130 plots would be needed to settle the families.

A soil survey involving 100 hectares was carried out on an area considered suitable for gravity irrigation. Complete soil analysis and the report of the reconnaissance survey are not available but the preliminary results indicate the occurrence of several soils. The soils have top soil textures ranging from clay to sandy loam. Subsoil textures on the other hand range from clay to loamy sand and sand. Some soils are either saline, alkaline or both. The alkaline and saline-alkaline soils are clearly unsuitable for irrigation whereas the saline soils will require the leaching of the salts and guarding against further salt build up.

OTHER INVESTIGATIONS.—N.N.N. AND P. OCHIENG

Experiments were continued to find a suitable method for analysis of total copper so that it would be used for the assessment and delineation of copper deficient areas. Out of the five methods used, the wet digestion with perchloric acid (after Homes*) followed by copper determination (after Andrus†) was successful in all types of soils although it gives lower figures compared to those obtained by other methods.

*R. S. Homes, 1945, Soil Sci. *58*, 77.

†S. Andrus, 1955, Analyst *80*, 154

SOIL PHYSICS—N. N. NYANDAT

Water Relations of Alluvial Silts, Grumusols and Saline—Alkaline Soils

(*i*) *Exchangeable Na and ESP levels in a Grumusol.*—In the 1969 Annual Report it was noted that an ESP of 3.6 per cent in the grumusols from Ahero, Nyanza Province, was sufficient to reduce their permeability. This finding implied that the soil could be classified as alkaline at this low ESP if the ESP was the dominant factor impairing drainage. An investigation was therefore carried out to find out the relationship between the exchangeable sodium and permeability when exchangeable sodium was deliberately reduced. The initial properties of the soils are shown in Table 1.

TABLE 1—SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF A GRUMUSOL

TEXTURE %			C.E.C. m.e. %	EXCHANGEABLE BASES m.e. %				ESP %	pH 1:1	E.C. 1:1
Sand	Silt	Clay		Ca	Mg	K	Na			
14	26	60	40	26·2	3·3	2·0	1·2	3·0	6·5	0·79

The heavy black clay soil characterized in Table I was treated with a strong solution of $CaCl_2$. The excess salt was leached using distilled water. Both treated and untreated soils were subsequently leached with tap water until the infiltration rate remained constant (*see* the 1969 Annual Report). Results are given in Table 2.

TABLE 2—EFFECT OF LEACHING WITH $CaCl_2$ SOLUTION ON EXCHANGEABLE BASES, ESP, INFILTRATION RATE AND pH ON A GRUMUSOL

TREATMENT	EXCHANGEABLE BASES m.e. %				ESP %	Infiltration ml/hr	pH 1:1
	Ca	Mg	K	Na			
Untreated	26·2	3·3	2·0	1·20	3·0	2·0	6·5
$CaCl_2$ leached ..	29·6	0·0	1·7	0·95	2·4	2·2	6·8

It is observed from Table 2 that in terms of magnitude there is no relation between ESP and infiltration. This picture is clearer when the previous year's data are taken into consideration. Other factors, presumably swelling of the montmorillonite fraction of the clay may be responsible for promoting the very slow drainage.

It appears almost impossible to replace wholly the exchangeable sodium in this soil. Whereas all exchangeable Mg has been virtually replaced by Ca the amount of Na replaced is only 0.25 m.e. per cent. The concentration of the $CaCl_2$ solution used in this experiment is far greater than concentrated gypsum solution and should therefore be capable of replacing more Na. This goes further to suggest that the gypsum applied on the grumusols in the soil exchange complex especially when the ESP is in the region of 2-4 per cent.

It is interesting to note that pH of the soil was only slightly raised by Ca treatment. This probably arose by the replacement of H ions by Ca ions.

(*ii*) *Depth of Incorporation and Rates of Gypsum Application.*—Gypsum is applied to the slow draining heavy black clays for soil amendment. The actual function of gypsum in these soils with the exchangeable sodium averaging about 1.0 m.e. per cent and ESP less than 15 is not well-known although it is considered that it flocculates the swelling montmorillonites. If the main function is to arrest this dispersion, then the depth of placement would be important. Field experiments have shown that

application of gypsum at the rate of 10 tonnes per hectare had a depressive effect yieldwise whereas 3.7 tonnes per hectare was about optimal. No reason for this behaviour is known and it would be of interest to know the rate of gypsum depression after application.

A laboratory experiment involving the rates and depths of gypsum incorporation was conducted. Soil ground to pass through a 0.5 mm. screen was mixed with gypsum at rates equivalent to 3.75, 5.00 and 7.50 tonnes per hectare calculated on the basis of 30 cm. soil column.

The soils were packed to a predetermined bulk density of 1.3 gm/cm^3. In one series gypsum was incorporated in the entire 30 cm. column while in the other it was incorporated in the 15 cm. The soil columns were wetted by capilarity and then leached with tap water. Measurement of the leachate and the electrical conductivity were taken weekly. The following were the general observations:—

(1) The soil mixed with gypsum throughout the 30 cm. column wetted faster. This took 3 to 4 days while the other series took about 2 weeks to wet through.

(2) The 30 cm. mix reached the highest electrical conductivity earlier, at least by one week.

(3) Infiltration was greater in the 30 cm. than in the 15 cm. mix, even after six months leaching.

(4) The amounts of gypsum in the leachate (determined semi-quantitatively by acetone method) were, in all cases, less than 1 m.e. per litre.

(*iii*) *Follow up of Gypsum Applied on Grumusols in* 1956 *and* 1963.—In the 1967 and 1969 Annual Reports of the Senior Sugar Research Officer; reports of the effects of gypsum, green manure and filter press mud applied during 1956 and topdressed in 1963 on the yield of sugarcane were presented. The site was revisited during the year and evaluated for any residual differences that might be apparent. The following were observed:—

(1) Drainage was fairly good, at least for the top 30 cm. This is however, attributed to the sandy nature of the top soil. The swelling and shrinking arising from wetting and drying of the soils and the accompanying cracking and sealing of the crack results in formation of sand veins which greatly increases hydraulic conductivities.

(2) Gypsum content of the soil was very low, of the order of 0.003 per cent by weight. No differences were detected between the untreated plots and the 1956, 1963 or those plots on which gypsum was superimposed in 1963 on the 1956 dressing. It appeared that all gypsum had been washed out of the soil.

(3) The effects of green manure and filter press mud are no longer evident seven years after application. Soil analysis indicated possible deficiencies in K, P, N and Mn.

Soil Mineralogy—G. Hinga

The Soil Mineralogy Unit continued to provide services to soil scientists in Kenya, Uganda, Tanzania and Ethiopia. In all, a total of 242 samples were analysed for their clay mineral composition. Some selected samples were also analysed for major primary minerals in the silt and sand fractions. Details of the results are given for some of the soils from Kenya.

Lambwe Valley

This area has been earmarked for development and the soil survey was carried out in 1965. About 75 per cent of the clay fraction consists of montmorillonite and vermiculite, the former being predominant. The rest of the clay consists of poorly crystallized illite. Very minor quantities of kaolin occur in some of the profiles. The majority of these soils are rich in feldspars. Calcite was detected in a few samples.

Ramisi Sugar Estates, Kwale

The soils covered four sites, namely Famuni, Mulimani, Mabatani and Bodo. The Famuni profile is dominated by montmorillonite and appears to be interlayered with some other materials which tend to stop it from contracting completely. A small amount of kaolin is also present. In Mulimani and Mabatani profiles kaolin is predominant but there are lesser quantities of 2:1 type clay minerals. Bodo profile contains 1:1, 2:1 types of clay minerals and illite, in that order of magnitude. The 2:1 types material appears to be vermiculite and montmorillonite which are interlayered.

Amboseli Game Reserve

These soils were found to have very high cation exchange capacities and it was decided to examine the clay fraction and find the reason for the phenomenon. The 2:1 type of the material is predominant but very poorly defined. It has no expanding properties and while some of the material contracts to a spacing of 10Å, others remain at 14-15Å even with potassium saturation plus heat treatment. The heat treatment results in a range of spacing from 10-14Å which is characteristic of interstratified clay minerals.

Mwea Cotton Research Station

Soils from five profiles were analysed. In four of the profiles the dominant clay mineral was metahalloysite with small amounts of illite. The red colour of these soils was associated with iron oxides whose removal with sodium dithionite bleached the clay slightly. More important was the improvement of the definition and intensity of the peaks. The fifth profile contained an interstratified 2:1 expanding type of clay mineral. Metahalloysite was identified. The intensity of the peaks improved with depth.

Faculty of Agriculture Farm—Nairobi

The clay fraction of the red soils is dominated with kaolin which appears to be metahalloysite. Also present are varying amounts of illite. The removal of iron oxide with sodium dithionite improved the intensity of the peaks and facilitated the identification of illite. Both clay minerals are poorly crystallized.

The dark brown soils found in the depressions are seasonally waterlogged and in one case the water table occurs at 38 cm. Under such circumstances there occurs accumulation of cations and this, coupled with poor drainage has resulted in the formation of montmorillonite which expands from 15.66-17.66Å when solvated. Metahalloysite accounts for 20-30 per cent of the clay mineral.

Soils of the Uasin Gishu Plateau

Soils were collected from ten regions and analysed for the type of clay mineral present. The following are the observations:—

(i) *Eldoret Farmers Training Centre.*—Both kaolin and illite occur but they are very poorly crystallized and hence have low intensities.

(ii) *Vyas Farm, Eldoret.*—Kaolin is predominant with traces of illite in the top 30 cm. 2:1 type of minerals occur in the bottom horizons. In the potassium saturated state the spacings range from 10-15.49Å and no changes are observed even with heat treatment. The material must be interstratified.

(iii) *Cowan Farm, Moiben.*—Very poorly crystallized kaolin and illite occur in this profile. The intensity of the peaks is extremely low. There are traces of 2:1 type clay minerals in the bottom horizons.

(iv) *Rai Agricultural Enterprises, Sergoit.*—The profile was taken from a valley. Kaolin and illite occur in both top and bottom horizons but both are poorly crystallized. Traces of 2:1 type occur in the top horizon but appreciable quantities are found in the bottom horizon. Expansion is from 15.49-20Å

(v) *Tooly Farm, Sergoit.*—A fairly well crystallized kaolin is predominant with about 15 per cent poorly defined illite. Traces of 2:1 expanding type are found in the top horizon but there are appreciable amounts of it in the bottom horizon.

(vi) *Eland Estate, Sergoit.*—Kaolin and illite occur together with 2:1 type clay minerals. All are generally poorly crystallized.

(vii) *Elgeyo Border.*—Kaolin is practically the only clay mineral present but there are traces of illite in the bottom horizons.

(viii) *Fenwick's Farm, Plateau.*—Kaolin and illite are present but very poorly crystallized. There is a slight trace of 2:1 type in the bottom horizons.

(ix) *Outspan Estate.*—Kaolin and illite are the dominant clay minerals but they are poorly defined. Traces of 2:1 type material occur in both horizon.

(x) *Kipsomba Estate, Soy.*—Kaolin is predominant throughout but there are traces of illite which show up better following heat treatment.

From the above analysis it is observed that these soils exhibit varying degrees of weathering as exemplified by the content of feldspars in the silt and sand fractions. At sites (i), (ii) and (iv) appreciable amounts of feldspars in silt and sand and substantial quantities of quartz were encountered. Goethite was also present in addition to substantial amounts of iron and manganese concretions. At sites (iii), (viii) and (ix) there was plenty of feldspars in silt but in lesser amounts in the sand fraction. This indicates that the soils are moderately weathered. At sites (iv), (v) and (vii) there were lots of feldspars in the silt fraction but there was even more in the sand fraction. Site (iv) was the richest in feldspars having about 90 per cent in sand fraction. These soils are therefore relatively unweathered. Site (x) is intensively weathered as indicated by the very little amount of feldspars in the silt fraction and practically nothing in the sand fraction.

These soils are essentially kaolinitic and as such low in cation exchange capacities. They tend to be low in plant nutrients, especially K and Ca. Furthermore, free aluminium and iron oxides which are associated with low pH and acid kaolin tend to render phospate unavailable to plants. This fixation may prevent a response to phosphatic fertilizers.

PHOSPHATE SORPTION STUDIES—G. HINGA

The soil samples from the phosphate trial (Annual Report 1969) were fractionated for aluminium-iron and calcium-phosphate following the method of Chang and Jackson.

The results indicate that the amount of P adsorbed by Al, Fe and Ca increases with addition of phosphate. The amount of Al-P was the lowest of the three fractions in the control but increased faster than the other two with the addition of phosphate. At the high levels of P, Al-P was equal to Fe-P or Ca-P but with the bracken zone soils it exceeded that of the other fractions. The amount of available P increased with the addition of P. However, some of the acid soils required as much as 500 ppm P to recover 20 ppm. This line of investigations will in future be conducted under field conditions.

Factors limiting wheat yields in Uasin Gishu Plateau

For several years wheat yields and those of other crops have been generally lower in the Uasin Gishu Plateau than in other areas enjoying similar types of climate even on well managed farms. Visual assessments indicate good growth but actual grain harvests are generally poor.

Although the soils are acid, low in calcium and available P the application of lime and phosphate improved yields only slightly. In order to assess the limiting factors chemical and physical characteristics of these soils were determined on soils obtained from well managed farms in the Sergoit Plateau wheat belt, Moiben (high fertility area for comparison) and Soy (a sulphur deficiency area).

It was found that poor yields are associated with shallow soils, low N and P levels, low pH and calcium status. With the exception of the depth factor others can be corrected through the application of the appropriate fertilizers.

In general, good fields had a pH of 5.3 and above with adequate supply of calcium in the top soil. Conversely, the poor fields had a pH lower than 5.2 in addition to poor calcium status. The permeability of the poor fields was low and this tended to encourage surface runoff in the rainy period. Poor soil structure was also encountered in this region.

Improved yields can be obtained by discontinuation of fertilizers based on diammonium phosphate and fertilizers of low base status. Instead phosphatic fertilizers based on single superphosphate should be encouraged especially on soil having pH below 5.2.

CROP PRODUCTS QUALITY—P. E. LIKIMANI

Copra

Small-scale farmers sun dry copra for 3-4 days during the sunny months and resort to smoke drying during the rainy season. This results in copra of high moisture content being delivered to the millers. Samples of copra obtained from farmers in Kilifi District were examined with the following observations:—

(i) Copra with moisture content exceeding 8 per cent was heavily infested with mould. The dominant organisms were *Aspergillus* and *Penicillium* with significant growth of *Mucor* and *Cladosporium*. There were no discernable differences in the occurrence of these organisms in copra dried to various moisture levels. Copra derived from immature fruit had, however, a high incidence of *Fusarium* infestation.

(ii) Kiln dried copra at a moisture level of 7.2 per cent was not subject to such infestation on subsequent storage. However, 60 per cent of kiln-dried copra dried in the rainy period (May-June) was infested with *Aspergillus* and *Penicillium*. The moisture content of such copra averaged 12.4 per cent.

(iii) Fruit dried during the rainy period is normally wrinkled. This is generally observed with immature fruits. The wrinkling may also arise from orientation of the fruit during drying.

(iv) Highly mouldy copra in the mills was associated with *Necrobia rufipes* De G., a small dark blue-green beetle.

Random samples of copra stored in factories for varying periods were taken for analysis of various qualities. The results are tabulated in Table 3.

TABLE 3—QUALITY ASSESSMENT OF COPRA DRIED TO DIFFERENT MOISTURE LEVELS

Sample No.	% Moisture	% Oil M.F.B.*	% Free Fatty Acids	Refractive Index (30°C)	Remarks
1	5·72	62·1	1·21	—	Laboratory dried (90°C) forced air oven.
2	5·79	63·4	1·09	—	Laboratory dried (90°C) best fruit.
3	7·20	61·4	1·54	1·4490	Kiln dried, sunny month.
4	7·23	57·7	1·72	1·4514	Kiln dried, rainy period.
5	8·45	48·7	3·42	—	Laboratory dried, immature, two month storage.
6	9·40	51·4	5·80	—	Miller's product, two month storage.
7	10·12	56·1	3·10	1·4522	Kiln dried, mouldy.
8	11·40	49·4	6·78	1·4571	Miller's immature, two month storage.
9	13·40	52·3	6·10	1·4568	Farmer's copra, very mouldy.
10	13·70	50·1	7·40	1·4572	Smoke dried, rainy season.
11	22·20	59·7	1·94	—	Farmer's copra, 2 days sun dried.

*Moisture free basis

The above figures show that the moisture level, and to some extent the degree of fruit maturity are decisive in the subsequent copra quality. Sample No. 2, obtained from an exporting large-scale producer, had the clearest oil, low content of free fatty acids and the highest oil content. It was impossible to lower the moisture content of immature fruit (sample 5) below 8.45 per cent with forced air oven at 90°C. The copra derived from this sample was wrinkled, rubber-like, had grown mouldy, had a low fat content and a high incidence of free fatty acids.

Citrus

The effect of N P K fertilizer combinations on the quality of citrus fruit (variety Washington Navel) was assessed in the laboratory. The fruit was picked at the height of production (July) from an orchard at the Horticultural Research Station, Thika. Good citrus quality consists of high juice and ascorbic acid content, low titratable acidity, large fruit size and attractive colour. Table 4 shows the results obtained.

TABLE 4—INFLUENCE OF FERTILIZERS ON THE QUALITY OF CITRUS FRUIT

Quantity N:P:K gm/tree	0:0:0	225:450:225	150:22:175 + F.Y.M.	375:472:400 + F.Y.M.	195:112:175
Quality assessed					
Volume of juice per cent W/W.. ..	30·4	35·6	35·2	28·8	36·3
Per cent acidity (as citrus acid A.C.) ..	0·58	0·65	0·66	0·54	0·64
Total soluble solids per cent (T.S.S.) ..	7·58	8·02	7·63	7·02	7·61
Refractive index (20°C)	1·3450	1·3454	1·3444	1·3458	1·3450
Ascorbic Acid (mg/ 100 gm)	48·7	46·2	45·6	45·6	44·3
Peel thickness index	180	180	156	174	115
Flavours score (out of 10)	5	5	3	4	5

There was a clear difference in juice quantity between the unfertilized and the fertilized plots. The highest dosage was detrimental to the amount of juice extracted and had low total soluble solids (the lower limit for quality fruit should be 10 per cent).

Whereas the entire crop had good qualities as exemplified by yield of juice, high ascorbic acid and low titratable acidity, the fruits displayed poor qualities as far as total soluble solids, flavour (low sugar and limonin contents) and juice colour were concerned. These qualities, however, are greatly influenced by weather conditions and experiments will be continued until a clearer picture of the effect of weather is apparent.

Macadamia Nuts

Chemical changes (especially rancidity) that occur in macadamia nuts during storage were investigated. These were obtained from a plantation at Thika. After storing in three ways, viz; unshelled dehusked nuts, kernels in sealed and unsealed polythene bags at ambient temperature both at the plantation and at the laboratories, the nuts were analysed for various qualities.

Moisture was determined at 70°C in a vacuum oven (120 mmHg) to constant weight (this took 188 hours to achieve). Samples were subsequently extracted with peroxide-free diethyl ether for 8 hours and the last traces of the solvent removed in vacuo. Iodine number was determined by the Hanus method. Reducing sugars were determined colorimetrically before and after HCl inversion. Results of the various qualities for two variations *M. integrifolia* and *M. tetraphylla* are compared in Table 5.

Results indicate that macadamia nuts stored at ambient temperatures undergo adverse changes when the initial moisture content of the kernels has not been reduced by drying. A period of three months was sufficient to raise the level of free fatty acids, and reducing sugars and lower the level of total sugars. As expected there was no appreciable change in iodine number or oil content.

Both varieties appear to undergo almost identical changes. However, the rough shelled *M. tetraphylla* was subject to less cracking of the shell and retained higher moisture content. This retention of moisture is not accompanied by increased chemical deterioration.

TABLE 5—EFFECT OF STORAGE PERIOD ON THE QUALITY OF TWO VARIETIES OF MACADAMIA NUTS

Storage Treatment Fresh		Un-shelled	Sealed Poly-thene	Open Poly-thene	Un-shelled	Sealed Poly-thene	Open Poly-thene
QUALITY ASSESSED							
Variety Macadamia Integrifolia							
Per cent free fatty acids (as oleic)	0·46	1·37	1·46	1·31	2·84	2·72	2·43
Hanus iodine number ..	81·2	81·4	80·9	81·6	80·4	79·8	78·7
Per cent total sugar ..	5·62	3·36	3·23	3·41	2·92	2·77	2·64
Per cent reducing sugars ..	0·34	0·85	0·94	0·78	1·13	1·26	1·18
Per cent moisture content ..	4·61	4·21	4·45	4·03	3·73	4·32	3·45
Per cent oil content ..	63·6	62·4	63·1	62·7	63·5	63·2	63·0
Variety Macadamia Tetraphyla							
Free fatty acids (as oleic) ..	0·43	1·35	1·44	1·34	2·86	2·86	2·46
Hanus iodine number ..	81·6	81·4	81·7	81·5	81·2	81·6	81·3
Per cent total sugars ..	5·42	3·14	3·16	3·43	3·04	2·97	2·88
Per cent reducing sugars ..	0·41	0·78	0·76	0·81	1·10	1·27	1·23
Per cent moisture content ..	4·73	4·62	4·56	4·37	4·15	3·76	3·62
Per cent oil content ..	64·5	64·6	64·3	63·8	64·5	63·8	63·7

PAPAIN—P. E. LIKIMANI

Two varieties of *Carica papaya* (Kiru and Honeydew) were compared for the proteolytic activity of activated latex (0.5 per cent) sodium metabisulphite (SMBS) and the residual SO_2 after drying at various temperatures. The samples were stored in amber glass bottles and protected from light. SO_2 was determined by the Monier-Williams methods. The drying temperatures for the filtered latex were 60, 70 and 90°C in a forced air oven. Results are shown in Table 6.

The temperature of 90°C was found to be too high for drying the latex. The stored latex in dry form was found to be coloured and of poor proteolytic activity. Variety Honeydew lost its activity of both activated and non-activated samples faster than Kiru and retained more SO_2. Proteolytic activity were disappointingly low.

TABLE 6—EFFECT OF DRYING TEMPERATURES ON THE LATEX ACTIVITY OF TWO VARIETIES OF PAWPAW

Carica Papaya	Variety Kiru			Variety Honeydew		
Drying temperature °C ..	60	70	90	60	70	90
Per cent moisture content ..	5·61	5·42	5·15	5·83	5·44	5·37
Activity (untreated)	130	124	96	112	90	87
Activity (treated SMBS) ..	234	216	184	221	206	173
Residual SO_2 (ppm)	540	536	410	635	580	515
Activity (after 60 days) ..	167	134	113	113	126	119

The unit continued to offer analytical and advisory service to the farming community, commercial firms and other scientists. In total 2262 samples of feedstuffs, fertilizer nutrient contents, and irrigation and boiler water qualities were received for analysis.

Observation Trial: Castor Varieties

Twenty-two varieties of castor (*Ricinus communis*) ten imported and twelve local selections were grown at N.A.L. for observation purposes. Spacing was 90 cm. x 90 cm. and each plot was 11 m. x 3.3 m. giving a total of 40 plants. Two fertilizer regimes (0 and 440 kg/hectare superphosphate) were imposed on each variety and general observation made during the growing period.

(i) Germination counts were made two weeks after planting. Germination was satisfactory in all varieties, although imported varieties were earlier. According to the origin, germination was as follows:—

Imported	Local
86·80%	85·04%
SE± 2·70	SE ± 2·68

(ii) Germination was compared according to fertilizer treatments. The presence of P gave higher germination percentages but this did not attain significance.

+P	−P
88·77%	82·91%
SE ± 1·97	SE ± 2·52

(iii) Seven months after planting, none of the local varieties had seed ready for picking. Imported varieties on the other hand had mature seed ready for picking ranging from 10-97 per cent.

(iv) Rust and insect infestation were found on lower leaves and the severity of the two were correlated. It was later noted that yellow insects fed on the fungus.

(v) Phosphatic fertilizer increased the oil contents of the seed as follows:—

+P	−P
44·76%	42·05%
SE ± 0·56	SE ± 0·56
+P > −P at	p < 0·01

(vi) When grouped together according to the origin, there was no significant difference in the oil content between imported and local varieties. On the average, however, local varieties showed a higher oil content.

Local	Imported
44·01%	42·69%
SE ± 0·78	SE ± 0·73

(vii) Seed yield varied considerably with different varieties. However, the mean yield for local varieties was greater than for the imported varieties.

Local	Imported
21·3 kg.	13·2 kg.
SE ± 3·51	SE ± 1·03

A point to be borne in mind in this generalization is that local varieties are perennial while those imported are annuals.

(viii) The yield were also grouped according to fertilizer treatment. It was observed that the yield was higher in phosphate applied plots but the difference did not attain statistical significance.

+P	−P
18·18 kg.	15·84 kg.
SE ± 2·06	SE ± 1·88

Feed Values of Cyperus papyrus

Feed values of *Cyperus papyrus* were analysed and compared with those of three grass species. These are of special value to the Range Management Division as they are indicative of the possible supplemental feed for livestock during the dry period when grazing is scarce. Table 7 shows the results.

TABLE 7—FEED VALUES OF *C. Papyrus* AND 3 GRASS SPECIES

QUALITY	% DM	% CP	% CF	% EE
Grass Species				
C. papyrus				
Rhizome	23·5	4·87	35·12	0·29
Stem	37·2	7·21	32·36	0·71
Flowers	86·1	8·33	19·17	2·06
Sporobolus pellucides	—	4·34	37·81	1·29
Brothriochloa insculpta	—	2·85	31·62	1·60
Bronchiaria lachmantha	—	3·37	32·99	1·15
Mean	48·93	5·16	31·81	1·18
S.E.	±19·02	±0·89	±2·63	±0·26

Methods of Analysis

The Animal Feedstuffs Analysis Committee was formed early in the year so that those engaged in analytical work could compare the methodologies of their laboratories. Table 8 shows results obtained by the four different institutions participating in the reference service.

The following conclusion can be made from Table 8:—

(i) *Polard Sample*

(*a*) *Ash*

E.A.A.F.R.O. figure is significantly different from the other three.

(*b*) *Crude Protein*

University, E.A.A.F.R.O., Naivasha > N.A.L.
University, E.A.A.F.R.O., Naivasha N.S.

(*c*) *Crude Fibre*

University > E.A.A.F.R.O., N.A.L. Naivasha.
E.A.A.F.R.O., N.A.L., Naivasha N.S.

(*d*) *Soluble carbohydrates*

N.A.L. > University.
E.A.A.F.R.O., University, N.S.

(*e*) *Crude Oil*

No significant difference between the three.

(ii) *Maize meal sample*

(*a*) *Ash*
N.A.L. > Naivasha
N.A.L., E.A.A.F.R.O., University N.S.
Naivasha, E.A.A.F.R.O., University N.S.

(*b*) *Crude Protein*
E.A.A.F.R.O. > N.A.L., Naivasha, University
N.A.L., Naivasha, University N.S.

(*c*) *Crude Fibre*
University, N.A.L., Naivasha N.S.
E.A.A.F.R.O., N.A.L., Naivasha N.S.
University, > E.A.A.F.R.O.

(*d*) *Soluble Carbohydrates*
E.A.A.F.R.O., University N.S.
E.A.A.F.R.O. > N.A.L.
N.A.L., University N.S.

(iii) *Cotton Seed Cake*

(*a*) *Ash*
Naivasha > N.A.L., E.A.A.F.R.O., University
N.A.L., E.A.A.F.R.O., University N.S.

(*b*) *Crude Protein*
University > E.A.A.F.R.O., N.A.L., Naivasha
E.A.A.F.R.O., N.A.L., Naivasha N.S.

(*c*) *Crude Fibre*
University > E.A.A.F.R.O., N.A.L.
University, Naivasha N.S.
E.A.A.F.R.O., N.A.L., Naivasha N.S.

(*d*) *Soluble carbohydrates*
University > E.A.A.F.R.O.
N.A.L., University N.S.
E.A.A.F.R.O., N.A.L. N.S.

TABLE 8—ANALYTICAL RESULTS OF 3 FEEDSTUFFS FROM 4 INSTITUTIONS

INSTITUTION	% ASH	% C.P.	% C.F.	% N.F.E.	% E.E.
	POLARD SAMPLE				
University	4·2	19·2	10·1	60·7	5·2
E.A.A.F.R.O.	6·0	19·0	8·1	61·9	5·0
N.A.L.	4·1	18·4	8·7	63·6	5·2
Naivasha	4·2	19·2	8·6	—	—
Means	4·625	18·950	8·875	62·067	5·133
S.E.	±0·459	±0·189	±0·429	±0·842	±0·071
	MAIZE MEAL				
University	1·5	9·1	4·4	79·0	6·0
E.A.A.F.R.O.	1·4	10·4	1·8	81·1	5·3
N.A.L.	1·8	9·4	3·1	78·8	6·9
Naivasha	1·1	8·9	3·2	—	—
Means	1·450	9·945	3·125	79·633	6·067
S.E.	±0·144	±0·333	±0·532	±0·737	±0·464

TABLE 8—(*Contd.*)

COTTON SEED CAKE

University	6·8	45·6	16·2	24·0	9·4
E.A.A.F.R.O.	6·8	43·3	12·0	30·9	7·0
N.A.L.	6·7	43·8	12·8	29·5	8·2
Naivasha	7·0	43·1	14·5	—	—
Means	6·825	43·950	13·875	28·133	8·200
S.E.	±0·065	±0·570	±0·934	±2·109	±0·694

C.P. = Crude Protein.
C.F. = Crude Fibre.
N.F.E. = Nitrogen Free Extract (soluble carbohydrates).
E.E. = Ether Extract (Crude oil).

SOILS ADVISORY LABORATORY—H. R. KURIA

The unit continued to provide services and advice to other organizations interested in soils, fertilizers, irrigation, water and crop quality. In all a total of 11,822 samples were handled and consisted of the following: soils (8,966), plant materials (2,327), feedstuffs (252), manures and fertilizers (35) and water (222). The Coffee Research Foundation accounted for about one-quarter of the total soil samples passing through the laboratory. The rest were mainly derived from research stations, the Soil Survey Unit, the general farming community and the University of Nairobi. Of interest were the 190 soil samples received from Ethiopia. A few others were received from the neighbouring countries for mineralogical analysis.

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Gitau J. K.—Getting most out of the Soil—*Kenya Farmer*—December 1970.

Pinkerton A., Thiesen, A.A. and Tubb, D.J. (1970): Comparison of X-ray spectrochemical and chemical analyses for micronutrient in plant tissue. *E. Afr.* agri. F.J.35: 231-3.

S. N. MUTURI.*
Acting Senior Soil Chemist

*Mr. J. K. Gitau, Senior Soil Chemist, was transferred to the Head Office at beginning of November, 1970, and was succeeded by Mr. S. N. Muturi, who compiled the Report.

II—PLANT PATHOLOGY

ADVISORY SERVICES—N. K. PATEL AND RUTH GATUMBI

During the year 332 specimens were received for disease diagnosis and advice. Of these about 48 per cent were of vegetable crops. About 63 per cent of the specimens were collected by Government officers. Out of station visits were also undertaken.

Prolonged heavy rains and cool weather conditions during the first half of the year favoured widespread occurrence of diseases like Blight (*Phytophthora infestans*) on potatoes and tomatoes, and Anthracnose (*Colletotrichum lindemuthianum*) and leaf spot (*Isariopsis griseola*) on beans. Rice at Ahero Irrigation Scheme suffered heavily from Blast (*Pyricularia oryzae*) and leaf spot (*Cercospora oryzae*), a new disease in Kenya. Root knot nematodes (*Meloidogyne spp.*) are still a cause for concern. Some farmers could considerably reduce disease problems if they practised correct agronomic practices as well as planting disease-free materials.

Some of the common disease problems reported are listed below.

(1) VEGETABLE CROPS

Beans (*Phaseolus vulgaris*)

This crop still remains one of the most important fresh vegetable crops for export. Serious losses occurred due to diseases like Anthracnose (*Colletotrichum lindemuthianum*) and leaf spot (*Isariopsis griseola*) favoured by wet and cool conditions. Infected seeds in cases of Anthracnose play an important part in the epidemic. Virus diseases were also common.

Valor (*Lablab niger var. bengalensis*)

Mildew (*Leveillula taurica*) causing severe damage was recorded for the first time on this crop. Bacterial leaf spot (? *Pseudomonas sp.*) a new record, is under investigation. Root knot nematodes (*Meloidogyne sp.*) also caused severe damage.

Sweet peppers and Chillies (*Capsicum spp.*)

Mildew (*Leveillula taurica*) which causes severe defoliation is an important disease and the results of investigation of control measures with fungicides are reported elsewhere.

Potatoes

Climatic conditions were ideal for blight (*Phytophthora infestans*) causing severe losses. Bacterial wilt (*Pseudomonas solanacearum*) is still a major disease. The results of research on Bacterial Wilt are reported elsewhere in this report.

Tomatoes

As in potatoes, Blight (*Phytophthora infestans*) caused severe losses. Bacterial canker (*Corynebacterium michiganense*) is a cause for concern. The crop also suffered from Bacterial Wilt (*Pseudomonas solanacearum*) and Root Knot Nematodes (*Meloidogyne sp.*)

Cucurbits

Most of the crops suffered from Powdery Mildew (*Erysiphe cichoracearum*) and Downy Mildew (*Pseudoperonospora cubensis*). Stem Rot (*Mycosphaerella melonis*) caused damage in some crops. Gummosis (*Cladosporium cucumerinum*) was reported on courgette crop.

Cabbages

Black Rot (*Xanthomonas campestris*) was widespread.

Peas

The crop suffered from Mildew (*Erysiphe cichoracearum*) and Leaf Spot (*Ascochyta pisii*).

Pigeon Pea

Wilt (*Fusarium udum*) and Leaf Spot (*Cercospora cajani*) were observed on this crop.

(2) Fruit Crops

Mangoes

Powdery Mildew (*Oidium mangiferae*) is still a cause for concern.

Macadamia Nuts

The crop suffered from flower drop and so far no significant pathogen has been found.

(3) Cereals and Grasses

Rice at Ahero Irrigation Scheme suffered heavily from Blast (*Pyricularia oryzae*), Leaf Spot (*Cercospora oryzae*) a new disease in Kenya, and also *Helminthosporium sp.* infection.

Maize

Maize streak was reported to be widespread in the Central region of the country.

Sorghum

Ergot (*Claviceps sp.*) and White Blight (*Helminthosporium turcicum*) were reported.

(4) Miscellaneous Crops

Carnations

Rust (*Uromyces dianthi*) was reported from many places in the carnation growing area.

Bougainvillea

Pseudomonas stizolobii which causes leaf spot and previously reported from Rhodesia was recorded for the first time in this country. So far the disease has been observed only at Mombasa.

Lucerne

The crop suffered from Downy Mildew (*Peronospora trifoliorum*) Leaf Spot (*Pseudopezizamedicaginis*) and Rust (*Uromyces striatus*).

(5) Mycological Herbarium

Host Lists of Kenya Fungi and Bacteria was increased by the additions listed below. Interesting new records are *Alternaria passiflorae* on *Passiflorae ichlemana, Cercospora oryzae* on Rice. *Helminthosporium musaesapientum* on *Strelitzia reginae, Botrytis cinerea,* on groundnuts, *Protomyces sp.* (tentative identification) on *Galinsoga parviflora* and *Pseudomonas stizolobii* on *Bougainvillea.*

Host	Organism	I.M.I. No.
Arachis hypogaea	*Botrytis cinerea*	150944
Asystasia schingeri	*Cicinnobolus cesatii* on *Oidium sp.* ..	150793
Bougainvillea sp.	*Alternaria tenuissima*	148386c
	Cladosporium oxysporum	148386b
	Clomerella cingulata (colletotrichum state)	148386a
Chenopodium fasciculosum var. *muraliforme*	*Stagonospora striplicis*	150268
Chrysanthemum cinerariifolium	*Chaetomium cochliodes*	148599
	Gliocladium roseum	151436
Commelina benghalensis	*Pyricularia oryzae* var. *commelinae* ..	150791
Galinsoga parviflora	*Protomyces sp.* .. .. Prof. J. S. Karling.	
Hibiscus esculentum	*Verticillium dahliae*	151435
Lablab purpureus var. *bengalensis* (Syn. *L. niger*)	*Leveillula taurica*	150266 150267
Oryza sativa	*Cercospora oryzae*	152460
Passiflora eichleriana	*Alternaria passiflorae*	148179
Passiflora ligulis	*Alternaria passiflorae*	150792
Passiflora quadragnularis	*Alternaria passiflorae*	150943
Solanum mauritianum	*Cercospora brachycarpa*	150790
Strelitzia reginae	*Helminthosporium musaesapientum* ..	147334
Bougaunvillea sp.	*Pseudomonas stizolobii*	b4376

Potato Blight (*Phytophthora infestans*)—J. J. Ondieki

Trials started in 1968 to test various fungicides for the control of potato late blight were concluded in 1970. During 1970 blight incidence was serious and offered good testing conditions. A very susceptible variety, Clivia, was used. The efficiency of the various fungicides in disease control was compared to copper (perenox). Five spray applications were done at 10 days interval.

Most of the fungicides used afforded good protection of the foliage; this was as a result of early spray applications before appearance of disease symptoms. The most effective fungicides in reducing foliar symptoms were the tin-derived fungicides—Brestan 60 and Decafention-maneb, and the dithiorcarbamate fungicides—Dithane M-45 and Manzate D. These were closely followed by Antracol, Parzate, and Duter 50. All these fungicides were significantly superior to copper (perenox) used as the control. In general, tin-containing fungicides were the most effective in the control of foliar symptoms but were observed to cause phytotoxicity in varying degrees depending on the source and composition of the tin-containing fungicides. Thus, Brestan 60 and Decafentin were more phytotoxic than Fennite or Decafentinmaneb.

Tuber yields showed that tin-containing fungicides, with the exception of Fennite, reduced yields when compared to the dithiorcarbamate fungicides. The following fungicides gave the highest yields: Parzate, Antracol, Fennite, Dithane M-45, Manzate D, Zineb, Cufram Z and Difolatan. Yields from copper and copper-containing fungicide treated plots were moderate whilst those of tin-containing fungicide treated were the least. The reduction is attributed to the phytotoxic effect of tin-containing fungicides.

From the results obtained it is recommended to use dithiorcarbamate fungicides like Dithane M-45, Manzate D, and Antracol which give good control of the disease on the foliage as well as high tuber yields. Copper or copper-containing fungicides should be applied late in the season following a few sprays with dithiorcarbamate fungicides, or in special cases should be applied alternately with dithiorcarbamate fungicides. Tin-containing fungicides, although giving excellent foliar disease control, should only be used by experienced farmers to avoid any risk of phytotoxicity.

Powdery Mildew of Capsicums (*Leveillula taurica*)—J. J. Ondieki

Glasshouse investigations into the chemical control of a powdery mildew of Capsicums were undertaken during the year. Fungicides tested included systemic and non-systemic compounds. Systemic fungicides were applied as sprays and as a drench, whereas the non-systemics were applied as sprays only.

Benomyl was the outstanding fungicide in controlling mildew when applied as a spray before or after disease appearance. Cercobin NF35 and Karathane also gave good control. When applied as a drench Benomyl and Cercobin NF35 were significantly better than the other fungicides when applied before appearance of the disease. Benomyl was significantly better than the other fungicides when applied after appearance of disease symptoms.

Bacterial Wilt (*Pseudomonas solanacearum*)—A. H. Ramos

Work continued on the testing of two lines of tomato, SI and S4, found to show resistance to *P. solanacearum* in the previous year. The trial design was a complete randomized block having four treatments as follows:—

Treatment 1	Early Beauty (susceptible control) on highly contaminated land.
Treatment 2	Resistant variety DI on highly contaminated land.
Treatment 3	Resistant variety S4 on highly contaminated land.
Treatment 4	Early Beauty (susceptible control) on highly contaminated land which was under a one-year cover of grass.

The results of this experiment were analysed by the probit method with time of exposure as dosage. Table 1 summarizes the results:—

TABLE I

Treatment	*Time for 50 per cent wilting*	*Slope of probit lines*
Treatment 1..	36 days	4·6
Treatment 2..	102 days	2·9
Treatment 3..	117 days	2·3
Treatment 4..	96 days	4·6

The following conclusions may be drawn:—

(*a*) The probit lines of treatments 1 and 4 have the same slope hence can be compared quantitatively. A one-year grass fallow reduces inoculum three times.

(*b*) The resistant varieties SI and S4 have probit lines of a lower slope indicating a high variation in susceptibility and hence the possibility of single plant selections.

(*c*) It also becomes obvious from the above results that the control of bacterial wilt cannot be achieved by rotation or the use of resistant varieties alone but by a combination of both.

PYRETHRUM—W. WAMBUGU

Wilt Condition

A wilt condition on pyrethrum plants was observed. Symptoms were blackening of the basal parts of the bush leading to wilting. The condition was most pronounced on the clone 4331 at and around Molo area but has also been reported in nurseries and fields in the Kisii and Kiambu Districts. It appears that the condition is more prevalent during the dry season but it is not attributed to drought, though it may be aggravated by it.

Isolations made from the affected parts yielded a number of fungi and nematodes.

Pathogenicity studies gave negative results. Further investigations will be carried out in 1971.

Flowers lacking Petals

A condition of flowers developing without petals was observed and was suspected to be caused by an attack of *Epicoccum sp.* An isolate of this fungus was obtained from Molo and inoculation test on buds of the clone Ma/63 gave 5 out of 24 flowers without petals and 13 out of 24 uninoculated flower buds did not produce petals. It is thought that this condition is genetic.

SUGAR-CANE—M. P. EARLY

(A) General

A survey was carried out, in co-operation with E.A.A.F.R.O. staff to look at incidences of diseases and assess yield losses. The more important diseases, brown spot, and smut were assessed as giving the following yield losses in the two sugar-growing areas:—

	Brown spot	*Smut*
	per cent	*per cent*
Nyanza	6·5	2·1
Coast..	2·0	1·1

The presence of ratoon stunting disease has not been established, but the lower average ratoon yield depression in cane from heat treated material over non heat-treated material suggests the virus may be present and causing some losses.

(B) Smut: caused by *Ustilago scitamineae* Syd.

(1) *Laboratory testing.*—Of 79 varieties tested by spraying buds with a smut spore suspension, 4 have shown high susceptibility and will not be put into field resistance trials. A further 26 varieties are currently being tested.

(2) *Nyanza Smut Testing.*—In the old smut testing trial, 6 out of 64 varieties have been discarded as susceptible. The remaining varieties are being tested in a new trial, since the previous trial was not giving reliable results.

(3) *Coast Smut Testing.*—Difficulty was encountered in establishing inoculum-spreading stools in two of the four blocks. For this reason, the results were inconclusive. However, six of the 56 varieties under test were obviously susceptible and have been discarded.

(4) *Epidemiology.*—A trial designed to measure the increase in disease in two varieties differing in susceptibility, is indicating that roguing in the susceptible variety ratoon crop is ineffective because the emerging tillers and the side buds are infectable by low concentrations of spores, and because spore production between roguings is profuse. Results from the more resistant variety are not yet conclusive.

(C) Mosaic

Observations were made in the plant crops and first ratoons in 32 varieties planted in variety trials, 21 varieties showed some symptoms after germination. However, all but 3 varieties appeared to "grow away" from the disease. The very poor yield values in these 3 varieties (P.O.J. 2822, P.O.J. 3150, and P.R. 975), can be largely attributed to the disease. It was noticeable that the mosaic incidence in the Kibos and Kimwani trials was more than in the Miwani trials.

(D) Ratoon Stunting disease

A trial has been established to find differences in growth and yield of cane inoculated with juice from a suspected diseased field of Co.421 and of uninoculated cane. Three varieties, M423/41, PR 980 and Q 67 were inoculated.

RICE—M. P. EARLY

Blast caused by *Pyricularia oryzae*

An American identification of *P. oryzae* obtained from Kenya on infected leaves and heads gives the race number as 1E-3 (International) or number 44 (American).

Four grasses (*Echinochloa colonum*, 3 not yet identified) were observed to be growing near the rice paddies and to have leaf spots caused by *Pyricularia sp.* None of these isolates has been successfully inoculated onto rice.

Other Diseases

Cercospora oryzae Miyake was reported for the first time in Kenya on the variety Sindano.

Fusarium monilifome Sheld. was found associated with stem borer damage in several IRRI varieties.

BANANAS—M. P. EARLY

A trial to test the resistances of 39 varieties of banana to Panama disease caused by *Fusarium oxysoporum f. cubense* has been planted using as inoculum source affected pseudostems which had been chopped up and mixed into the planting hole.

CASHEW—M. P. EARLY

A cashew nut die back condition suspected of being caused by a fungus, has now been established as an entomological problem caused by *Pseudotheraptus* and *Helopeltis spp.*

Rice

Rice Yellow Mottle

The incidence of rice yellow mottle (RYM) was locally very high at the Ahero Pilot Scheme in the variety "Sindano". After the harvest the fields are not tilled, consequently giving diseased ratoon rice to the young crop. Insects which transmit the virus can be found in high numbers on the ratoon rice and grasses of these harvested fields. Any control of the disease must therefore begin with good sanitation i.e. no ratoon rice, no abundant grass growth, and diseased rice on the bunds and along the ditches.

Rice "Basmati 217" attacked by RYM does not give clear symptoms in the field. At the Irrigation Research Station, Ahero, a small plot of ratoon rice of this variety was seriously affected by the disease, but was only showing mild mottling. Glasshouse experiments with the same variety, mechanically inoculated at two week intervals, showed that plants infected at a young stage were stunted and had no or little seed yield. In the last two cases the symptoms were not as clear as with "Sindano". In the field the danger exists that when nothing is done about the ratoon rice, "Basmati 217", which seems less susceptible than "Sindano" will be attacked at an early stage, consequently giving higher losses.

The following rice varieties have been tested by mechanical inoculation at the 3-5 leaf stage and all showed symptoms:—

Afaa Mwanza 1/133
Afaa Mwanza 1/159
Afaa Mwanza 0/746
Afaa Kilombero 0/906
Afaa Kilombero 1/196
Afaa Kilombero 2/214
Afaa Kilombero
Basmati
Basmati 217
Basmati 972
Bayu
Bitamatami
Bungala
Demarara creale 2/100
Faya SI
Gamti
Introduction 1/324
Kangala
Kialangawa
Kinawa chekundu
Kibawa cheupe
Kosura
K×270/20
K×C 803/6
Lindi safari
Madevu
Maliakuna
Mbuyu
Milfor
Mkarafuu
Perolla
Portugue
Radin Goi
S.C. 70
Shingo la Majani
Sindano
Sindano Nsemevu
Uchuki
Ungambi
White
Zira
IR 5
IR 8
IR 12
IR 12–178–2–3–
IR 20
IR 22
IR 52
IR 52–18–2
IR 127–80–1–10
IR 154
IR 154–61–1–1
IR 520–1–26–3–3
IR 661–1–140–3–2
IR 661–1–170–3–3
IR 662–2–7–2–2
IR 665–24–1
IR 665–29–2
IR 773–A1–36–2–1
IR 790–28–6
IR 878–B2–62–2

In the field some varieties "Radin Goi", "IR 5" and "IR 8" showed a clear orange discoloration of the leaves in the early stage of disease development.

Apart from *Seselia pusilla* Gerstaecker (Galerucinae), insects belonging to the subfamilies Hispinae and Halticinae were able to transmit RYMV and are consequently regarded to be vectors of this virus. S. *pusilla* was able to transmit RYMV after an acquisition and inoculation period of 15 minutes.

Courgette

Watermelon mosaic

An attempt to produce an antiserum failed. Research into this disease was discontinued and a paper about the disease has been submitted for publication.

Passiflora spp.

Woodiness and other virus disease

In the Rikenye valley near Keroka the purple passionfruit (*Passiflora edulis*) was severely attacked by woodiness. As a correlation is thought to exist between temperature/rainfall and severity of the disease, it was advised to select warmer areas for growing this crop. No new plantations should be established in this area. The following aphids were collected from passionfruit in the valley: *Uroleucon compositae* Theob., *Toxoptera citricidus* Kirk. and *Aphis fabae* Scop.

Partially purified suspensions obtained from *P. eichleriana* leaves with mosaic symptoms from Nairobi, examined in an electron microscope, contained long flexuous rods.

SEED TESTING LABORATORY—D. M. NDUNGU

A total of 4362 samples yielding a revenue of Sh. 11,202/00 were received during the year. This was an increase of 601 samples over the previous year and is the highest number ever recorded. An analysis of the samples is as follows:—

	Samples
1. *Commercial Samples*	
(*a*) Cereals and Field Crops	1,093
(*b*) Grasses	297
(*c*) Vegetable	698
TOTAL	2,088
2. *Government Samples*	
(*a*) All crops except grasses	1,642
(*b*) Grasses	632
TOTAL	2,274
GRAND TOTAL	4,362

The germination and purity testing for the Seed Wheat Certification Scheme continued. During 1970, 22 certificates were issued. Six certificates for Purity and Germination of Government Tested Seed were issued for export of seed. 79 entries were tested for the Farm and Daidy Produce Section of the Agricultural Society of Kenya Shows.

The Kenya Inspection Service for Seeds in Kitale is now responsible for drawing all Official Samples (mainly Hybrid Maize and Pasture Grass seeds) to be submitted to the Seed Laboratory for Purity and Germination Tests.

A series of purity and germination tests on pyrethrum which started in 1968 continued.

The laboratory participated in the Referee Seed Testing of samples received from the International Seed Testing Association (I.S.T.A.) Results from this station were very encouraging.

J. J. ONDIEKI,
Senior Plant Pathologist.

III—ENTOMOLOGY

Wheat—R. G. Allan

No major outbreaks of insect pests occurred in the Province during the year although damage to crops on a few farms was unusually severe and was caused by insects not generally of economic importance on the crop. Semi-loopers, *Plusia orichalcea,* American Bollworm, *Heliothis armigera,* and Armyworm, *Spodoptera exempta,* caused considerable damage to wheat on a farm in the Rongai area. Aerial application of DDT controlled the insects but was carried out too late to offset the cost of spray treatment against crop lost to the insects. An unidentified caterpillar moved from pigweed onto the crop as it was ripening. No control measures were taken.

The Oat Aphid, *Macrosiphon avenae,* occurred in the largest numbers seen to date on wheat in Kenya. Aerial spraying was carried out on about 700 hectares mostly with dimethoate and control was good. The economic return from the spray treatment was difficult to estimate but it was assessed that on only about 225 hectares was the cost of spraying recovered by the resulting yield increase. The Ladybird, *Adonia variegata* predated on the aphid and up to 17 per cent were parasitized.

One farmer in the Rongai area lost well over 50 per cent of his crop in a 13 hectare field heavily infested with a mycoplasma. Wheat at the Plant Breeding Station, Njoro was similarly damaged particularly in the breeding cages. Sampling at Rongai, with a sweepnet, produced an average of 100 specimens of jassids and delphacids in 10 sample sweeps. Specimens were sent to Commonwealth Institute of Entomology for identification. Seventy-five per cent of the population was made up of 2 delphacid and jassid species. Nine other species occurred, three delphacids and six jassids. At the time sampling, 10 weeks after planting, 77% of the population was adult although no nymphs of 5 jassids species were collected. Numerically the delphacids were three times as numerous as jassids. *Cicadulina mbila* and *C. bipunctella* were the only species identified. At the Plant Breeding Station, Njoro, a series of trials in cages to determine the vector of the mycoplasma was carried out and it was established that one of the delphacids was the principal vector.

During the examination of wheat plants from the infected field at Rongai about 1 in 1,000 plants were found to be infected with a mite which has been tentatively identified as *Siteroptes graminum* Reuter. A single specimen, others having been accidentally lost, has been sent to Canada for identification. The mites were found, averaging 8 individuals per plant, inside the hollow internode clustered together and associated with a brown necrotic area of the stem. This necrotic patch was commonly found in the absence of the mites. All mites found were gravid females with distended hysterostomas.

Armyworm, *Spodoptera exempta,* occurred at relatively low densities on wheat throughout the Province and although a large acreage was sprayed, principally with DDT 75% by fixed wing aircraft, little economic gain was attributable to removal of the armyworm which caused little damage to the crop.

Barley—R. G. A.

The incidence of the Rice Root Aphid, *Rhopalosiphum rufiabdominalis,* was high and a considerable amount of losses in barley were attributed by farmers to the depredations of this insect. Examination of a number of reported cases failed to pinpoint this insect at the causative agent and a combination trial of fertilizer and insecticide was undertaken.

A randomized block design was used with plots of 800 square metres. Four treatments, sulphate of ammonia, demeton-S-methyl 25% at 285 ml. per acre, thiometon 25% at 200 cc per acre and an untreated control were replicated three times. Insecticides were applied by tractor mounted boom sprayer moving at 1 m.p.h. to give an output of 225 litres/hectare. Neither insecticide treatment had any discernible effect on the Rice Root Aphid population when compared with control plots but there was a significantly higher populations of aphids on the fertilizer plots which out-yielded all other treatments. It was concluded that nitrogen leaching may have been the main cause of barley crop losses during the year.

The Barley-fly, *Delia* (*Hylemya*) *arambourgi*, were very numerous during the year and trials were carried out to examine the effect of the see dresssings on the populations of this insect. The trials were carried out mainly to examine the opinion of many farmers in the area that Barley-Fly had developed resistance to dieldrin. A number of 3x3 latin square layouts of plots 2/3 of an acre in area were arranged on different farms. The variety used was Research Barley. The seed was dressed at the normal seed dressing rate of 16 ozs. per bag of barley with a proprietary brand of a mercurial seed dressing which acted as control and two insecticidal seed treatments. Treated plots were dressed with a proprietary mercurial plus dieldrin seed dressing and an experimental formulation of pirimiphos-ethyl.

Barley-Fly damage was first noticed on plots planted with seed dressed with mercurial seed dressing alone and those dressed with pirimiphos-ethyl 11 days after planting. A fortnight after planting 11% of eggs in the field had hatched and larvae were in the seedlings. Three per cent of the larvae were in the 1st instar stage, not yet in he plant, and 1% hatched on the day of sampling.

Eighteen days after planting 82% of eggs found in the field had hatched.

Average per foot row	Mercury alone	Mercury dieldrin	Primiphos ethyl
Eggs	6·0	6·2	9·6
Per cent infested seedlings (2 weeks after sowing) ..	58	29	36
No. of dead plants (3 weeks after sowing)	2·1	0·3	0·3
Per cent infested seedlings (5 weeks after sowing) ..	51·2	60	58·5
Per cent infested seedlings (8 weeks after sowing) ..	64·7	6·8	35·2
Per cent increase over controls (170 days after sowing) ..	—	59·3	58·7

The trial results are complicated slightly by the fact more eggs were laid in the plots treated with pirimiphos-ethyl. This may have been due to females being attracted by the yellowness of the plants as a side effect of the seed dressing which slightly, but significantly depressed germination. Two weeks after planting there were fewer larvae in treated plants than in untreated and in the third week seedlings died at a significantly higher rate in untreated than treated plots. The second generation of Barley-Fly in the crop and progeny of new immigrants five weeks after planting showed no significant difference in numbers between treatments but the third generation and second generation recent immigrants 8 weeks after planting, showed a marked reduction in the numbers in the dieldrin treated plots.

The possibility of killing Barley-Fly larvae in the plant by applying systemic insecticides was examined in another trial. Dimethoate and formothion were examined but neither was shown to be effective.

PYRETHRUM—R. G. A.

Pyrethrum splits planted at Mau Narok where acreages are increasing rapidly were seen to be heavily infested with the eelworm, *Meloidogyne* sp. Heavy damage was done to a small acreage of pyrethrum in Central Province by snails. It was recommended that the pyrethrum be severely cut back and metaldehyde baits used to effect control.

HORTICULTURAL CROPS—R. G. A.

Severe damage was done to strawberries, celery, lettuce and seedlings of crucifers by slugs. The most effective method of control used on the farm was hand collecting by children.

An average of 1 gallon of slugs was collected daily and 2 gallons on Saturdays, i.e. 7 gallons a week mostly from a 4 acre plot ot artichokes. Despite this effort little reduction in the overall population was evident.

An appraisal of the situation was made and it was decided that a bait should be used in the strawberries but only a spray application would be effective in the more bushy courgettes and artichokes.

In the trials with baits on strawberries it was found that a proprietary bait of metaldehyde was attractive to slugs which were three times more numerous in plots baited with 5 pellets per square foot than in other plots. At this high density, 26.8 slugs per square foot, the mortality was only 4.5 per cent due, possibly, to the coating of the pellets with slime. With only one or two pellets per square foot there was no significant attraction of slugs from unbaited areas, the density being about 8.1 per square foot. At this density the mortality was 38.3 per cent. Mercaptodimethur proprietary bait at 5 pellets per square foot gave the best control of 71.2 per cent after a single application. Reapplication of the baits at the rate of 1 per square foot applied 4 times at an interval of 3 days resulted in 92 per cent control with metaldehyde and 80 per cent with mercaptodimethur.

In the spray trial on artichokes metaldehyde failed to give adequate control but mercaptodimethur wettable powder at 175 mg a.i. per plant gave 100 per cent control of slugs and was still giving better control than metaldehyde at 20 mg a.i. per plant.

RODENT RESEARCH—K. D. TAYLOR

Outbreaks of field rats occur relatively infrequently in Kenya but when they do occur, widespread damage to cereal crops may result; and in the past Rift Valley Province has been particularly badly affected. Two species of rat are of major importance; the Grass Rat, *Arvicanthis niloticus,* and the Multimammate Rat, *Mastomys natalensis.* A third species, the Zebra Mouse, *Rhabdomys pumilio,* is of secondary importance. Rodenticides were used on a large scale to control rats principally at Endebess and Nakuru in 1962 and in 1968, but, while these campaigns were to some extent successful, they proved to be expensive and difficult to organize. The widespread use of rodenticides also always involves risk of accidental poisoning in man and domestic animals.

A programme of research into the ecology of the pest species was begun in December 1969 with the object of determining the causes of rat outbreaks. It was thought that if these were known, outbreaks might be predicted and some means of preventing them might ultimately be devised.

The initial phase of the programme is scheduled to run for 2½ years.

Samples of rodents were being taken more or less regularly using a standard technique from 13 sites around Nakuru and Endebess. Cereal crops, fallow land and grassland were sampled, and data on population density, food and reproduction were collected, the data being related to the type of environment in which the rodents are living.

The results so far obtained suggest that within cereal-growing areas, the pest species are found mainly in arable land as opposed to grassland, and that their reproduction is to some extent linked to the presence of grain in fields. Non-pest species, principally the Vlei Rat, *Otomys irroratus* occur in the grassland and arable land and seem to reproduce with equal facility in both environments (*see* Table below). The indication is that outbreaks of the pest species develop in arable land—not in grassland—and are dependent on the presence of grain in the fields. Any circumstance that leads to late or inefficient harvesting of cereals is therefore likely to favour reprodution amongst cereal-eating rats and may ultimately lead to an outbreak. But there are clearly other factors involved. For instance, the presence of cover is very important and rodents do not survive in areas of poor cover even when grain is plentiful. Also, *Arvicanthis* occurs commonly in grassland outside cereal-growing areas and may reach quite high densities in such places. There are many aspects of rodent outbreaks that are yet to be understood, but at the present stage of the programme, it appears that more efficient gleaning of cereal crops and co-ordinated destruction of cover during the dry season would do much to lessen the severity of rat outbreaks.

Summary of Trapping Results at 13 Sites, Nine in Nakuru and Four at Endebess

		Arable, ripe or ripening grain present	Arable, no grain present	Grass-land	Total
Number of Samples		28	21	25	74
Total traps laid		1,434	721	1,555	3,710
Mastomys natalensis	Number caught	256	34	15	305
	Number caught per 100 traps	17·8	4·8	1·0	
	Adult females	100	10	0	110
	Per cent adult females breeding	79	30	—	74
Arvicanthis niloticus	Number caught	215	105	14	334
	Number caught per 100 traps	15·0	14·6	0·8	—
	Adult females	87	36	7	130
	Per cent adult females breeding	75	33	14	60
Rhabdomys pumilio	Number caught	183	6	42	231
	Number caught per 100 traps	12·8	0·8	2·6	—
	Adult females	83	3	15	101
	Per cent adult females breeding	82	(67)	27	73
Non-pest species particularly *Otomys irroratus*	Number caught	167	46	202	415
	Number caught per 100 traps	11·6	6·4	13·0	—
	Adult females	73	19	85	177
	Per cent adult females breeding	68	53	59	62
The three pest species only	Adult females breeding (per cent)	78	35	23	69

Cotton—G. R. Rens, J. H. Brettel

In Central and Eastern Provinces the long rains were very poor. Cotton in Kirinyaga, Embu and Kitui Districts was badly affected by the drought and late planted or late weeded fields had to be written off. In Kirinyaga and Meru Districts there was again a rise in the percentage of cotton acreage treated with insecticides, but a survey showed that many farmers were ignorant of the recommendations for spraying and did not apply the treatments at the right times and at the right rates. The introduction by the Cotton Lint and Seed Marketing Board of a new insecticide and a new sprayer for sale to cotton farmers was insufficiently prepared for and caused some confusion.

In Coast, Western and Nyanza Provinces, weather conditions were rather erratic, but not unfavourable to cotton growing. Fair to good yields were obtained, despite American Bollworm attacks.

At Wanguru and Kampi ya Mawe a system for the timing of sprays based on pest counts was compared with a regime in which a DDT/carbaryl mixture was sprayed at day intervals and with regimes of ten weekly applications, spraying for the first five times with DDT followed by five times carbaryl, or using DDT and carbaryl—gave the highest yields.

It was also shown that spraying during a period of 50 days as recommended, did not fully cover the period during which pest attacks were experienced. An increase in yield was obtained by prolonging pest control to 70 days.

At Kibos and Busia a regime of five weekly DDT sprays followed by five weekly carbaryl sprays, was compared to a regime of the same series of sprays but now at 10 day intervals, and to a regime of 5 sprays at 10 day intervals using a DDT/carbaryl mixture. No significant differences were found between the three regimes.

Despite the relatively dry weather conditions, cotton sown at Giaki as late as four weeks after the start of the rains, gave a slightly higher yield than cotton sown two to four weeks before that. Spraying, starting as early as at the beginning of flowering in December did not increase yields when compared with spraying starting at the onset of the long rains, as is recommended. Detailed records of the numbers of pests and the progress of plant growth show that early planted cotton experiences heavier attacks from bollworms and stops flowering at an earlier date than the later planted cotton. Early spraying reduces the number of early season bollworms later in the season, when the bulk of the crop is set. These results confirm earlier findings, that cotton at Giaki should be planted in early or mid-November and that sprays may be delayed until the onset of the long rains.

In a time of sowing and spraying trial at Kibos, cotton sown in October during the short rains was compared to cotton sown at the beginning of the long rains. On the previous two years, cotton sown during the short rains gave the highest yields, but this year the February-sown cotton yielded much better than the October-planted cotton. This reversal of previous results may be explained by the unusually high rainfall in January and February (250 mm), which caused a prolonged flowering of the early sown plants and a subsequent heavy build-up of Lygus, Bollworms and Stainers.

The laboratory screening of new insecticides for the control of Cotton Stainers continued. Eight new chemicals were tested. Two insecticides, Hoe2960 and CI7018, were very effective and Valexon was moderately active against Stainers.

In a trial at Kibos a mixture of DDT and carbaryl was compared to C8353 W.P., PP511 E.C., Valexon E.C. and C16220 W.P. Control of American Bollworm larvae by these new insecticides was very poor and none produced more than 60 per cent of the yield obtained with carbaryl/DDT mixture.

At Giaki and Kampi ya Mawe, BHC/DDT was compared to BHC/DDT/Toxaphene mixture, Mobam/Toxaphene, Gardona/Malathion, Hoe2960, endosulfan and endosulfan/arprocarb. No significant differences in yield were obtained, but in both tests endosulfan/arprocarb produced the highest yields. The addition of toxaphene to BHC/DDT improved the control of Spiny and American Bollworms.

At Wanguru the following ULV-formulations were compared both singly and combined with DDT: BHC, malathion, Valexon, phenthoate and BHC/toxaphene. There were no great differences in yield, but pest counts indicated good bollworm control by Valexon and good Stainer control by phenthoate and BHC.

An attempt was made to increase the effectiveness of insecticides by adding molasses to the spray mixture. It was hoped that the bollworm moths would be attracted by the mollasses and induced to feed on the molasses/insecticide mixture before they could lay any eggs. Molasses was added to carbaryl, arprocarb, phenthoate. Although good control of bollworms was obtained, the yields were no better than those of the standard carbaryl/DDT mixture.

Of all insecticides tested in recent years, only monocrotophos/DDT could consistently outyield carbaryl/DDT. There is a potential for this chemical when applied by air in large schemes, An ultra low volume spray trial was therefore laid down at Kampi ya Mawe to find the economic rates of application of monocrotophos, applied singly and in a mixture with DDT.

The results of this trial were not very conclusive, yields were somewhat higher than plots treated with BHC/DDT.

The last soil treatment experiment of a three year series of field trials was applied at Wanguru. Like in the other years, soil treatments kept Stainer populations down, but spraying against *Heliothis* and *Earias* attacks and also against migrating *Dysdercus* adults was nevertheless required.

It seems that in years of severe Stainer attacks, soil treatments may slow down the rate of increase of *Dysdercus* populations, permitting better control by the normal spraying regime. The addition of small quantities of diluent-adhesives to a DDT/carbaryl mixture caused a small, but economic increase in yield in a field trial at Giaki.

At Giaki and Kampi ya Mawe, spraying with a 'ULVA' Ulv--sprayer was compared to conventional spraying, using a 'Saval' knapsack pump. A similar trial was carried out at Msabaha, where weather conditions during the spray period are not very favourable for drift-spraying. The results from these three trials have given strong indications that the swath with for ULV treatments should not exceed three rows and that the volume of liquid applied per hectare should not be less than four litres. Furthermore, conventional spraying seemed more effective than the ultra low volume method of spraying.

At Kibos an experiment was conducted in which ULV-formulations of phenthoate and "Cottinex-plus" (DDT/BHC/dimethoate) were used. It was found that the most suitable time to spray at Kibos was around noon, when wind conditions are most favourable.

In two field trials at Wanguru, the effectiveness of nine hand spray pumps were compared. This was the second year in a three series of field tests, in which all knapsack sprayers available in East Africa are tested and compared. In addition to the field trials, laboratory tests were carried out to evaluate the robustness of the machines and to measure their spray coverage. Of the nine sprayers tested, the "Mesto" was outstanding among the small pumps and the "Saval" among the larger sprayers.

SUGAR-CANE—G.W. OLOO

The major sugar estates in Kenya remained affected by the Sugar-cane scale, *Aulacaspis tegalensis*, at varying levels of infestation. The scale infestation continued to be heavy at Ramisi, Coast Province, but there appeared to be no appreciable build-up in the Nyanza Province plantations. In fact, no *A. tegalensis* was seen at Chemelil during a recent visit (December, 1970) although this species had been recorded there.

Reports from Galole, Coast Province, where insecticides were being tested against the scale also indicated a general decline in scale populations.

The only new records during the year on scale incidence were those of *A. madiunensis* observed for the first time at Mumias on 9.4.70 and at Chemelil on 5.12.70. (This species had been recorded at Kakamega Research Station on 5.3.70). At Chemelil, *A. madiunensis* was found only in a bulking nursery plot. On the same plot (and same variety NCo. 310) another brown mussel-like armoured scale was collected from leaves and identified at the Commonwealth Institute of Entomology, as belonging to the species *Acanthomytilus sacchari* Hall (Diaspididae). Apparently, this is the first record of this scale insect on sugar-cane in East Africa, and its potential as a pest are still unknown. A soft scale (still to be identified) was also collected from leaves of NCo. 310 at Ramisi (Famoni Mlimani). The infestation was fairly high (accompanied by thick sooty mould on leaves) in localized areas; and severe attacks may spread to other parts of the estate.

Trials on controlling the sugar-cane scale were attempted in 1969 using eleven chemicals and repeated in 1970 using only the best five chemicals in the previous year's trial. These were white oil (Alboleum), mecarbam (Murphotox), azinphos-ethyl (Gusathion), malathion and diazinon. A randomized block design was used with 5 replicates and the materials were applied at 0.3 per cent a.i.

Analysis of Brix figures at harvest time produced no significant differences between treatments. No more chemical control trials are envisaged and efforts may have to be turned to finding out the possibilities of control using biological agents and improving cultural practices.

Laboratory studies of the biology and morphology of the scale have been concluded. In a laboratory maintained at temperatures ranging from 25.8°C minimum to 28.1°C maximum and about 78.5 per cent r.h., the complete life cycle, i.e. from crawler to crawler, took 32 days.

The females lived for about 40 days (range 21-51) as adults and laid an average of 580 eggs. Oviposition period lasted 8-38 days; incubation took 8 days; and about 97 per cent of the total eggs hatched. The crawling phase of the larval instar lasted 24-48 hours, with about 22 per cent of the larvae surviving through this phase to settle on the host material. Scale production started 24 hours after fixation, and differentiation occurred 8 days after eclosion. Adult males emerged 14 days after eclosion, mated, and died within 36 hours. Females also attained adult stage 14 days after eclosion and copulation took place on the same day.

Oviposition started 24-25 days after eclosion, continued daily for 8-38 days, the female dying 1-3 days after stopping egg-laying.

Work on morphology involved a review of the taxonomy of *A. tegalensis*, with figures and description presented. The studies revealed that the form that occurs at Ramisi differed in certain characters from the form that was described by Ferris from Formosa in 1922 and that described by Moutia from Mauritius in 1944, but that our insect was probably closer to that of Mauritius. Some of the differences among the three forms may be considered important enough to warrant revision of this species.

As was pointed out in the last Annual Report, chafer grub/beetle problem only occurs at Ramisi, and no reports of outbreak have been received from other plantations. At Ramisi, the greatest damage is caused by *Heteronychus andersoni* and *H. licas*, although other species, notably Schizonycha, also occur there. No quantitative estimate of loss has been made but the grubs are known to inflict severe damage in fields where there is a concentration of their numbers.

Some results have now been obtained from the Chemical control trial laid down at Gazi, Ramisi, in July, 1969. Three compounds were tested for effectiveness and persistence in this trial. These were: Aldrin, BHC and Birlane. A 5x5 latin square design was used and the treatments were as follows:—

Control	
Aldrin 40 per cent W.P.	5·6 kg. (2·2 kg. a.i.) per hectare
Aldrin 40 per cent W.P.	2·8 kg. (1.1 kg. a.i.) per hectare
B.H.C. 6·5 per cent (gamma) .. W.P. 34·5 kg...	(2·2 kg. a.i.) per hectare
Birlane 25 per cent W.P.	4·5 kg. (1·1 kg. a.i.) per hectares

The materials were diluted at the rate of 60 gallons per acre, and the spray mixture applied into furrows and on spaces between furrows using a knapsack sprayer. After planting, the furrows were covered by hand; and the inter-row spaces harrowed to work the chemical into top 3-4 inches.

First sampling was done just before treatment (and planting). The second batch of samples were taken 6 months after planting; thereafter sampling continued at monthly intervals to harvest, giving a total of 9 separate batches of samples. On each sampling occasion a total of 50 samples (i.e. 2 stools per plot) were taken by digging up a stool (a hole 30″ x 30″ wide; 12″ deep) and counting living grubs, pupae and adult beetles of *Heteronychus* spp. and *Schizonycha*. In the analysis, only data on *Heteronychus* spp. was considered, the number of other species being negligible.

The results of the experiment may be summarized as follows:—

(*a*) Application of Aldrin 40 per cent W.P. both at 5.6 kg. per hectare (5 lbs. per acre) and 2.8 kg. per hectare (2½ lbs. per acre) resulted in a significantly higher apparent mortality of *Heteronychus* spp. than Birlane, BHC and the control at the 1 per cent level of significance. However, there was no significant difference between the two levels of aldrin application (i.e. 5.6 kg. per hectare and 2.8 kg. per hectare).

(*b*) Birlane treatment gave significantly higher kill of grubs over the control at the 5 per cent level of significance, but was not significantly different from BHC treatment.

(*c*) There was no significant difference between BHC and the control.

It appears that Aldrin 40 per cent W.P. at 5.6 kg. per hectare and 2.8 kg. per hectare would give equal protection to the plant crop chafer grubs. The standard rate of application of this material is 5.6 kg. per hectare. Apparently, the grub population at Ramisi is still very vulnerable to chemical treatment, this being the first time they have been subjected to such treatment. Of even greater interest, perhaps, is the ability of the two levels of Aldrin application to protect ratoon crops.

Inspection of raw data showed that Birlane gave an initial high kill of the grubs for about 10 months after application at planting but appears to have been ineffective thereafter. Thus, it might be expected that single application of Birlane would not protect ratoon crops. But since it gave significant results on the plant crop at the 5 per cent level of significance, and being an organo-phosphorus material, it might prove useful as an alternative to Aldrin (an organo-chlorine compound) if the grubs eventually develop resistance to the latter.

BHC gave poor results in this trial, although reports indicate that it has been used successfully in Queensland, Australia. In other places its use has been discontinued because of its phytotoxicity.

On the basis of these results, therefore, Aldrin 40 per cent W.P. will be adopted for grub control at Ramisi, while Birlane 25 per cent W.P. will be taken as a possible alternative insecticide should the grubs develop tolerance or resistance to Aldrin, as has been the case at the Tanganyika Planting Company, Moshi, for example. In the next trial, optimum rate of Aldrin application will be tested before it is formally recommended. Meanwhile, the first trial will continue to second ratoon so as to test residual activity of aldrin; and to see whether repeated application of Birlane would give protection to the ratoon crops.

The borer situation has remained more or less the same as last year. *Sesamia calamistis* continued to inflict considerable damage on young cane in all estates but, fortunately, the damage is always compensated for by subsequent tillering. As such *Sesamia* is of little or no economic importance at the moment. *Chilo* spp. may also attack cane but causes no appreciable damage. There have been no reports of *Eldana saccharina* from any of the estates. Two surveys (one in March, the other in December were made during the year at Mumias but no *Eldana* was recovered. Borers may still be regarded as of minor importance in Kenya.

Termites, *Pseudacanthotermes militaris* and the Pink Mealybug, *Saccharicoccus sacchari* occur but are of minor economic importance. The root mealybug at Mumias, previously incorrectly referred to as *Dysmicoccus* has now been identified at the Commonwealth Institute of Entomology (British Museum) as belonging to the species *Trionymus pygmaeus* De Lotto (Pseudococcidae). The mealybug seems to have increased in numbers on irrigated plots at Mumias, although the overall infestation appears to be low.

There were two new records during the year, a brown mussel-like armoured scale from leaves of NCo. 310 at a nursery plot at Chemelil determined at the C.I.E. as *Acanthomytilus sacchari* Hall (Diaspididae); and a soft scale (accompanied by thick sooty mould) from leaves of NCo. 310 at Famoni Mlimani, Ramisi. The soft scale has still to be identified.

MAIZE—F. C. MATHEZ, R.G.A.

At the Coast, investigations on the morphology, biology and control of the coastal stalk borers *Chilo orichalcociliella, C. partellus* and *Sesamia calamistis* started in 1964, were completed. The results will be published elsewhere in the scientific press.

Studies on the chemical control of the stalk borers revealed that the use of carbaryl, 3 sprays at 10 days interval, starting 3 weeks after planting, reduced the population to as low as 20 per cent. However, the yields from sprayed and unsprayed plots did not differ significantly.

From plots which received no insecticides applications, yields of approximately 25-90 kg. bags per hectare were obtained, compared to an average of about 10 bags per hectare, commonly obtained by the farmers in the province. These results indicate that good management and proper cultural practices including the use of selected seeds, fertilizer application, proper spacing and regular weeding can appreciably increase the yields.

In the Rift Valley Province, and Central Kenya trials planned to examine new control methods for Maize Stalk Borer were not undertaken due to the low incidence of egg-laying and subsequent damage during the year.

In the Rift Valley Province, a fodder crop planted in November 1969 was heavily infested with the Lesser Armyworm, *Spodoptera exigua*, in January, and a nearby field was 100 per cent infested with Yellow Streak Virus. *Cicadulina mbila* was seen to be at a high population level in the crop. Thrips and Bagrada bugs, *B. cruciferarum*, were also present in large numbers; the Bagrada Bugs causing severe damage in the proximity of shade trees in the affected field.

WATTLE—P. KNUDSEN

Routine sampling of wattle insects continued during the year from a various plantations around Eldoret and Murang'a District. Results of the sampling in 1970 confirm those reported in 1969.

From field work, the insect species that cause damage have been found to belong to the family Miridae. The species causing the most severe damage is *Lygidolon elegans* and *L. laevigatum*. Minor damage is also caused by the jassids *Batrachomorphus caedaranus* and *B. segregatus* and a chrysomelid *Megalognatha aenea*. Other insects founds on wattle seem to do little or no damage at all.

The highest peak for Mirid population is mid-October with a population build-up beginning in the April/May period. After October the population starts declining. Damage to wattle appears 1-3 months after the Mirids are first noticed and is heralded by defoliation on top of the plants. With heavy infestations, plants can be completely defoliated with darkening and hardening of tissues. This condition may persist for up to 6 months. When new flesh sets in, profuse branching occurs causing the so-called "witche's broom" and necessitating expensive pruning. Heavy infestations during the first year may reduce gain in height by 50-60 per cent.

Greenhouse trials have been done with various insects collected from wattle. Caging *Batrachomorphus caedaranus* on some plants for up to 8 months produced some defoliation but no brooming or change of colour occurred. The chrysomelid *Megalognatha aenea* when caged for 2 months caused a very slight defoliation. 20-25 adults were used. These two insects can be termed of minor importance.

When either *Lygidolon elegans* or *L. laevigatum* were caged on wattle plants defoliation was apparent within 1 month and in 3 months brooming was apparent. In the greenhouse, there were up to 5 branches per broom as against an average of 20 branches per broom observed in the field.

Control trials with 1 per cent dimethoate-in-water sprays against Mirids were also carried out in the field. This was applied by air at fortnightly intervals. This controlled the Mirids and in cases where defoliation had taken place, plants had recovered completely 6-7 weeks after the first application of insecticide spray. More control trials will be carried out during the next year.

Distribution of *L. elegans* and *L. laevigatum* varies with locality. *L. elegans* is more abundant in Nandi, south of Eldoret while *L. laevigatum* is the more abundant in samples from Soy, north of Eldoret. Soy is 150 m lower than Nandi whose altitude is 2,100 m. In Murang'a District, samples taken from Kigumo Division showed that *L. laevigatum* occurred more frequently in samples collected from lower localities. From these same samples, a new Mirid, *L. hecate* has been described by Linnavouri. This occurred at varying frequencies but was the only species present at the highest collection locations i.e. between 2,200 and 2,300 m. Both *elegans* and *hecate* were found at localities with altitudes between 1,900 and 2,100 m. Between 1,630 and 1,800 m only *laevigatum* was found. These results are from one sampling at each location, no final conclusions can therefore be drawn and only with more sampling can the true distribution pattern be elucidated. This will be followed up later.

MANGO—H. L. ADENYA

The Mango Fruit Fly, *Ceratitis cosyra* and the Natal Fruit Fly, *C. rosa* damage mango fruits in the Coast Province. The former is considered to be the predominant species and was collected in all the principal mango-growing areas with the exception of Lamu, where the search did not yield a single specimen. The latter is less commonly found infesting mangoes and was collected from only two localities, Gazi and Mtwapa. *C. rosa* appears to prefer hosts other than mango, e.g. Bullock's heart, *Annona reticulata* and guava, *Psidium guajava*. On both these hosts damage by *C. rosa* is considerable; more than 80 per cent of the fruits being infested.

Some observations were made on the host plants, life history and habits of *C. cosyra* during the year. Eggs are laid in mature and ripening fruits, including fallen ones, in masses about 30, and several such batches may be deposited in a single fruit. Consequently, the number of larvae in infested fruits vary greatly. A count of larvae on 20 infested fruits gave figures ranging from 16 to 115 larvae per fruit. In Malindi area up to 25 per cent of the maiure fruits were found infested; in other areas it was much lower.

Pupation takes place in the soil, at depths not exceeding 3.0 cm, over 80 per cent of the pupae being found between soil surface and a depth of 1.5 cm.

A marked periodicity in the emergence of adults from puparia was found to occur in the species; the adults emerge only during the early hours of the evening, with a peak between 5.30 and 6.30 a.m. when over 60 per cent emerge.

C. cosyra has been recorded on a few wild hosts, namely *Warburgia ugandensis*, *Acokanthera longiflora* and *Cordyla africana*. During the investigation, it was collected from *Psidium guajava* (Guava) and sour orange *Citrus aurentium*.

In both cases, the fruits had been left on the trees until they were overripe. It is thus doubtful that these cultivated plants are important host of the fly. A further search in the same plants did not yield any specimens of *C. cosyra*. It is thus considered that mango is the only important host of this fly.

CASHEW—H.L.A.

The incidence of the cashew "die back" disease is widespread in the Coast Province, and it has been estimated that every year more than 30 per cent of the cashew nut produced is lost as a result of the disease.

At first it was suspected to be caused by a fungus, but all the fungi isolated from the infested shoots have been shown to be incapable of penetrating healthy tissues. It would appear that the fungi are not the primary causal organisms and that their entry into tissues is facilitated by initial injury of the plant.

A search for insect pests occurring on cashew was made over the period September to December 1970 and three bugs were found commonly feeding on the shoots and fruits. These are *Pseudotheraptus wayi, Helopeltis anacardii* and an unidentified pentatomid. Preliminary observations with bagged insects of the three species showed that the typical symptoms of the disease were only on the shoots on which *P. wayi* fed.

Field and laboratory studies on *P. wayi* are being undertaken; with particular reference to the nature of the damage and the relation of the bug to the cashew "die back". So far no conclusive results have been obtained on the field studies but in laboratory rearing of *P. wayi* on cashew fruits renewed every two days is successful. The larvae complete development; adults readily mate in the cages; about 100 eggs are laid per female over 90 per cent of which are fertile.

Adults can live for a period of up to 2 months.

ARMYWORM—J. B. MUTHAMIA

There were widespread armyworm outbreaks reported during the year some of which occurred in pastures as well as rangeland. The Ministry of Agriculture's Range Management Division were involved in controlling outbreaks on 2,000 ha. of rangeland. They utilized DDT 20 per cent oil solution sprayed by the Desert Locust Control Organization for Eastern Africa's aircraft. But the bulk of outbreaks on rangeland were left uncontrolled. Outbreaks on pastures as well as on graminaceous crops were sometimes sprayed.

The forecasting project initiated by the Armyworm Division of E.A.A.F.R.O. continued to function with the Senior Entomologist as the co-ordinating officer for traps run in Kenya. Progress on this is reported elsewhere.

ADVISORY—W. WAIHENYA

Approximately 100 specimens were examined during the year. These were mostly insects and plants of horticultural importance received from both farmers and the Ministry's extension staff as well as research stations. Several visits were made to farmers who had submitted specimens to facilitate on-the-spot assessment of pest level and damage.

BIOLOGICAL CONTROL OF WEEDS—J.B.M., R. HISCOCK (V.S.O., FISHERIES)

Salvinia

Shipments of insects for the control of *Salvinia* on Lake Naivasha continued. Adults of the acridid, *Paulinia acuminata* were reared either in tanks or on floating cages on the lake but due to the low night temperatures in Naivasha, this was not successful. Shipments of insects from a cooler climate similar to that of Naivasha will be arranged and releases made. Only a single shipment of the pyralid, *Samea multiplicalis* was received but this was in a bad condition due to the delays *en route*. There was no emergence. No shipment of the curculionid, *Cyrtobagus singularis* was received. Arrangements for shipment and release at Naivasha will be arranged.

Lantana

No new insect species were introduced for the control of *Lantana*. Some insects recommended for release from Hawaii and Australia were found to feed on economic plants and could therefore not be cleared for importation into East Africa.

STORED PRODUCTS

The 63rd-67th meeting of the Pest Infestation of Stored Products Committee were held in 1970.

WALLER (CYPRUS) BINS—A. A. BAKER

The trial storage of maize in two Kitale bins has now extended for two and a half years. Repeated temperature monitoring and grain sampling have indicated that this grain is still of the highest quality and that no deterioration has occurred either due to moisture migration or overheating. The temperatures within the grain bulk have in fact decreased by about 3°C, the maximum recorded over the past year being only 24°C. The moisture content overall has averaged about 12.3 per cent, but is about 1 per cent higher on the apical crust due to slight, very localized infestation of *Sitophilus* and *Tribolium,* which was in turn, due to structural air leakage around the top manhole. This infestation has since been eradicated by the application of aluminium phosphide tablets during routine grain sampling.

Analysis of the intergranular air has verified a lethal concentration of oxygen necessary for insect survival, generally about 25 per cent.

This trial will be terminated in June 1971, i.e. after three years storage, at which time, a detailed assessment of the grain quality and palatability will be possible in comparison to freshly harvested maize.

Most of the Nakuru bins were filled during 1969/70, but it was apparent that bulk wheat is far more difficult to store successfully than the larger grained maize. Due to a desire by the Wheat Board to move their produce for processing and because of a possible structural fault in the bins, no wheat was stored for more than 16 months. Even over such short periods, the grain in a number of cases heated to over 40°C, at which time the grain was moved elsewhere. Normal equilibration temperatures were between 25°C and 28°C, insect infestation was of a very low level, the grain moisture content well within acceptable limits and oxygen concentration in the grain mass about 5 per cent after approximately one year. It was thought that the high temperatures resulted from high concentrations of grain dust (in some cases, over 10 per cent by weight), and that a layering effect by this dust resulted during the filling operation. These layers of high dust concentration inhibited normal, intergranular air movement that usually results in the equilibration of temperature throughout. The actual mechanism of heating within and between these layers is not yet known.

To offset this phenomenon in the future, grain cleaning plants were recommended and will soon be under construction.

During 1969/70, the Nakuru site was operated at its maximum rate. It was very soon realized that many inefficiencies and inadequacies had not been considered under the initial contract. Specifically, if large-scale crop failure resulted in severe famine, relief food could not reach the consumer in time to offset starvation. At the same time, both sites needed certain modifications in order to become a part of the general country-wide scheme of a bag to bulk-handling system.

To this end, a number of trials were carried out with various types of conveying equipment and movements to rail and road transport etc. A scheme has since been presented to the Treasury for approval.

In addition to major structural additions to these installations, more efficient methods of grain grading and quality control have been proposed under the same scheme.

BULK HANDLING—A.A.B.

Probably the most severe bottleneck to any efficient bulk-handling system, is that of transport from farmers to central collection depots and between depots.

In order to provide some solution or at least some stop-gap measure on this requirement, numerous trials have been completed with both road and rail transport.

Normal covered long bogeys have been modified with baffle boards of various types and roof hatches, and filled with bulk maize and wheat both pneumatically and with auger conveyours. Trial consignments have been sent to Jinja and Mombasa and the entire operation assessed as an interim measure until such time as the East African Railways Corporation consider specialized bulk trucks economically feasible.

Fumigation of rail trucks containing bulk grain has proved to be promising but trials to finalize this method of disinfestation are envisaged within the coming year.

Equipment designed to aid the farmer in the reasonably cheap road transport of grain in bulk to his nearest depot has also been included in trials based around 40-ton bulk silos. As a result, this has been adopted in some isolated instances.

FARM SILOS—A.A.B.

The trials outlined in the last Annual Report have now been terminated. The trial data are outlined in Table 1, and a summary of grain analyses in Table 2.

The butyl/weldmesh storage silos were of undoubted success for both maize and wheat and also coffee, if filled at the normal, acceptable moisture contents. The butyl rubber that suffered such severe degradation in both trials was apparently from a bad production batch, normal butyl lasting for at least three years, from past trial experience. The seal around the auger shute assembly has also since been modified. With the above provisos, and taking into account past trial work with similar units, it is apparent that storage at farm level can be entirely successful for at least one year at moisture contents of up to 14.5 per cent (wheat), 13.5 per cent (maize), and from a trial carried out at Moshi, 10 per cent for coffee.

Similarly, with the hessian/weldmesh, drying, conditioning, storage and fumigation unit, a very promising idea could be developed if an unshrinkable overwrap could be supplied. The leakage that developed in both upcountry trials necessitated the early termination of an interesting experiment. Fumigation with aluminium phosphide tablets under the overwrap proved to be a promising operation. This trial will continue.

TABLE I—TRIAL DATA

Silo Grain	Location Erection date	Storage period	REASONS FOR TERMINATION
Butyl Maize ..	Kitale 26–8–69	10 months	Degradation, by ozone cracking of butyl rubber bag. Leakage of water around auger shute assembly. Storage period considered adequate.
Butyl Wheat ..	Nakuru 27–8–69	9 months	Slight degradation of butyl and slight insect infestation due to air ingression around auger shute assembly. Storage period considered adequate.
Hessian Maize ..	Kitale 9–9–69	3 months	Broken down very early due to extensive shrinkage of tarpaulin overwrap and water damage at base of silo. Leaks developed at top of overwrap resulting in extensive grain damage.
Hessian Wheat ..	Nakuru 11–9–69	8 months	Although not so severe as above, tarpaulin overwrap shrunk and was removed after 6 months, to be replaced by valeron. Leakage also occurred to a slight extent due to poor fabrication. Again, damage to grain by water ingression.
Hessian Maize ..	Mombasa 15–9–69	6 months	Shrinkage of overwrap and consequent reinfestation form adjacent godowns promoted termination after a sheet fumigation with phostoxin. On opening, however, contents found to be in excellent condition. Trial could have been extended although very high temperatures observed.
Hessian Wheat ..	Mombasa 15–6–69	6 months	

TABLE 2—SUMMARY OF GRAIN ANALYSIS

Silo/Location/Grain	Moisture content At Start Range	Average	Data % by Cera At Finish Range	Average	Temp. °C 12.00 a.m. Position	Start	Finish	% O_2 and CO^2 at termination of trial	Change in Average F.F.A. mg./KOH/kg.	Change in % Germination
Butyl/Kitale/Maize ..	11·1 to 13·2	12·2	12·2 to 13·5	12·5	Base ..	15·0	28·0	9·0 O_2	21·2 to 25·0	None
					Mid ..	19·0	26·0			Average 50%
					Top ..	17·5	19·5	6·0 CO_2		
Butyl/Nakuru/Wheat ..	13·1 to 14·4	13·8	13·2 to 14·5	13·6	Base ..	26·0	25·0	11·7 O_2	20·0 to 32·0	69 to 59
					Mid ..	29·0	26·0			
					Top ..	28·5	24·0	6·8 CO_2		
Hessian/Kitale/Maize ..	—No Change—				Base ..	25·0	23·5	—	—	—
					Mid ..	25·0	27·0			
					Top ..	26·5	26·0			
Hessian/Nakuru/Wheat..	13·4 to 14·9	14·0	12·4 to 15·2	13·8	Base ..	29·0	44·0	—	17 to 40·9	83 to 14·5
					Mid ..	23·5	32·0			
					Top ..	27·0	41·0			
Hessian Mombasa Maize	12·7 to 14·5	13·3	12·4 to 13·6	13·6	Base ..	29·5	38·5	—	No Change	68·5 to 31
					Mid ..	28·5	37·5			
					Top ..	30·0	39·0			
Hessian Mombasa Wheat	14·4 to 15·3	14·9	13·4 to 16·0	14·6	Base ..	29·0	39·5	—	23·5 to 31·3	20 to 4
					Mid ..	28·5	37·5			
					Top ..	37·5	39·5			

Insecticide Resistance—F. de Lima

In a survey to determine the incidence of lindane resistance in the country forty samples of the Maize Weevil, *Sitophilus zeamays* from twenty-three places in the main maize growing areas were assayed using lindane deposits on filter paper. Various levels of resistance were recorded by assessing strain mortalities in comparison with that of a standard susceptible strain. In general, strains from stores on Research Stations and Farmers' Training Centres had higher levels of lindane resistance. Strains from the Maize and Produce Board stores which handle most of the marketable produce in the country showed low levels of lindane resistance. No breakdown of control by lindane used at its present dosage was detected and neither was there any evidence of resistance at economic levels to the insecticide. It is concluded that lindane used as recommended can still protect stored grain from weevil damage.

Varietal Susceptibilities of Wheat to the Rice Weevil—F. de L.

The Rice Weevil, *Sitophilus oryzae*, is economically the most important pest of stored wheat in the country. Some varieties of wheat are less susceptible to damage by the weevil than others.

Eighteen wheat varieties of commercial importance were obtained from the Plant Breeding Station, Njoro. Two experiments were carried out to determine the susceptibilities of these varieties. The varieties Kenya Plume and Kenya Page were found to be the least susceptible to damage by the weevil.

Moisture Meter Calibration—F. de L.

The necessity of a suitable standard (reference) oven method for the determination of moisture content of cereals together with the calibration of the Cera, Marconi and Supermatic Moisture meters has long been felt by the wheat industry.

The two standard oven methods used are:—

1. Drying a ground cereal sample at 113°C for 4 hours in a mechanically ventilated oven.
2. Drying a ground cereal sample at 130°C for 1.5 hours in a mechanically ventilated oven.

Experiments using 27 wheat varieties of commercial importance were carried out to determine the following relationships:—

(1) The relationship between the reference oven methods.

(2) The relationship of the Marconi moisture meter with the reference oven methods.

(3) The relationship of the Marconi moisture meter with the Cera moisture meter.

(4) The relationship of the Marconi moisture meter with the Supermatic moisture meter.

(5) The relationship of the Cera moisture meter with the reference oven methods.

(6) The relationship of the Cera moisture meter with Supermatic moisture meter.

(7) The relationship of the Supermatic moisture meter with the reference oven methods.

These relationships are expressed as linear equations.

It was concluded that the oven method of drying a ground cereal sample at 130°C for 1.5 hours in a mechanically heated oven was the most suitable standard oven method. The Supermatic moisture meter was the most suitable meter for major wheat receiving centres and the Cera moisture meter was equally suitable at minor receiving centres and on the farm.

STORAGE ON SMALL FARMS—F. P. COYNE, F. DE L.

With the winding-up of the operations of the U.K. Freedom From Hunger Campaign Farm sponsored Storage Project in the second half of the year, the provinces initiated projects on similar lines in their districts. Twenty-two such maize storage schemes are operating in five provinces. The provincial breakdown is as follows:—

(1) Western Province	8
(2) Nyanza Province	4
(3) Rift Valley Province	3
(4) Central Province	3
(5) Eastern Province	4

Essentially, each scheme consists of approximately 250-300 farmers all living in one area which forms an isolated unit having natural boundaries. The farmers within this unit clean out their stores and then spraying of the stores is done using lindane 50 per cent W.P. All this is done at least 6 weeks before harvest. After harvest maize stored on cobs is treated with a 1 per cent lindane dust at 4 oz. per 9 cu. ft. of cobs. Shelled maize is treated with a 0.1 per cent lindane dust at 100 gms per 90 kg bag. Sorghum, millet, peas, beans, etc. are also treated with 0.1 per cent lindane. Data collection to compare the effect of the treatment is done by taking debe weighings inside and outside the scheme areas. The results of the work will be available next year.

SHIPBOARD STUDIES AND HOLD CLIMATE—J. A. MCFARLANE

Hold climate.—Air and sea temperatures and the temperature of loaded cargo influence the climate in the holds of cargo ships and the development of infestation in infestible cargoes. The humidity in ships holds, partly dependent upon these factors, can itself affect the quality of perishable cargoes. The object of this work is to relate the available data on air and sea temperatures for sea journeys from East Africa to Europe with more detailed records of actual climatic conditions in ships holds.

A preliminary study has been made on the M.V. "Harambee", from Mombasa to London, utilizing the ship's own records supplemented by thermohydrograph recordings in one hold, and meteorological sea-temperature readings. The extra data was obtained by a trainee meteorologist, Mr. S. Malissa, travelling with the vessel and I have to thank him for maintaining the thermohydrograph and making his other data available to me. The correlation of the data has still to be done.

More detailed studies will be undertaken this year, using automatic temperature recording equipment and thermohydrographs which will be installed in the holds of selected vessels sailing to Europe.

Insect Infestation.—The main object of this work is to assess the significance of low-level infestation in apparently clean cargo loaded at Mombasa in relation to the climatic studies described above and to studies on the incidence of infestation in cargo loaded at other ports on the eastern sea-bed of Africa. Some incidental work has been done on ships at Mombasa and a limited number of detailed studies on vessels travelling to Red Sea ports from Mombasa and back, and to Tanzania ports from Mombasa and back, are planned for 1971, beginning with a voyage to the Red Sea and back in March/April.

As an adjunct to this work a system of recording infestation pressure by the exposure of small "trap-bags" containing infestible material has been tested in the transit sheds at Kilindini. The method has been shown to provide useful and repeatable results and is now being introduced as a routine procedure by the Storage and Infestation Control Survey, with the Port Manager's approval, as a standard supplement to visual inspection in the port. An example of the information obtained is given in Table 1.

TABLE 1—MEAN NUMBER OF *Tribolium castaneum* PER 600g MAIZE FOR 5–10 TRAP-BAGS EXPOSED FOR 14–15 DAYS

Period	Shed A	Shed B	Shed C
26–8–9–9–70	0·1	—	—
18–9–2–10–70	0·4	0·7	1·2
15–10–29–10–70	0·6	0·3	0·4
13–11–28–11–70	0·0	1·3	0·8
23–12–6–1–71	1·4	2·8	2·1

Note: Other insects recorded include *Sitophilus oryzae, Attagenus* sp., (larvae), *Alphitobius laevigatus, Oryzaephilus* spp., *Ahasverus advena, Typhaea stercorea,* and the ootheca of a cockroach, probably *Periplaneta brunnea.* Numbers per bag are generally low except for the sporadic occurrence of large numbers of *Alphitobius, Typhaea,* and *Attagenus,* which are all residue pests.

The generally low numbers of, for example, *Tribolium* correlate with the relatively low apparent incidence of this major pest on consignments delivered to the port following the more stringent application of visual inspection procedures, pre-delivery disinfestation, and the rejection of consignments with evident infestation. However, they serve as a reminder that the quarantine against pests in the port area, maintained jointly by the Storage and Infestation Control Survey and the port authorities, is a partial quarantine which has successfully reduced the incidence of infestation in the port but cannot be expected to eliminate it completely. Nevertheless further improvement is possible. The recorded fluctuations in insect numbers generally correlate with the movement of certain types of commodity into the sheds or with the presence of neglected commodity residues. In several instances they have provided useful evidence of the serious effect of a particular consignment or residue in which infestation was initially overlooked. In the long term, data such as these can provide a means of assessing standards of pest-control in the port and of comparing them year by year.

DICHLORVOS FOR CONTROL OF THE TROPICAL WAREHOUSE MOTH—J. A. McF.

Trials in Nairobi and elsewhere have already demonstrated that dichlorvos can give excellent protection against reinfestation by the Tropical Warehouse moth, *Ephestia cautella* in up-country conditions and can give reasonably good suppression of an existing infestation by this pest.

The present trials aim to test this insecticide for control of the moth and some other pests in coastal conditions and to demonstrate a new application technique which permits easier and more economical use of this insecticide.

As a preliminary to the first full-scale trial a study of infestation levels in a series of four Mombasa godowns was carried out, using commercial "fly-papers" as a means of recording the presence of flying insects in the godowns. The results for *E. cautella* are summarized in Table 2, where Stores 2 and 4 are the stores in which the treatment will be applied and Stores 1 and 3 are those which will remain as untreated controls. This trial should also yield information on the effectiveness of the treatment against the beetle, *Lasioderma serricorne* and, *Tribolium castaneum.*

TABLE 2—MEAN NUMBER OF *Ephestia cautella* PER TRAP/WEEK

Period	Store 1	Store 2	Store 3	Store 4
7–14–10–70	34	19	20	36
14–21–10–70	63	16	36	91
25–10–2–11–70..	75	23	47	138
9–15–11–70*	42*	15*	15*	53*
23–30–11–70	144	20	39	187
7–13–11–71	131	41	69	154

*6–day record (all others 7 days).

Number of traps: 2 per store

BRUCHID INFESTATION OF COWPEAS AND GRAMS AT THE COAST—J. A. McF.

Replicated observation plots at Mtwapa, Mariakani, Matuga and Msabaha, harvested in September/October 1970, have confirmed that both cowpeas and grams are exposed to fairly heavy pre-harvest infestation by Bruchid beetles. *Bruchidius* and *Callosobruchus* species occurred at all sites but the former were relatively infrequent only at Msabaha while the latter were relatively infrequent at Mariakani only. The major storage pest (Callosobruchus) is represented by three species with *C. maculatus* and *C. rhodesianus* generally common and *C. chinensis* less so.

Infestation by non-storage pests, such as Lepidopterous pod-borers, *Piezotrachelus* spp., and Agromyzid flies which all inflict damage on the ripening seeds, appears to be much more sporadic and in this case was severe only at Msabaha. Climatic factors and/or differences in cultivation intensity may be responsible for the observed difference but no firm conclusion can be drawn at this stage.

Work in West Africa reported by Prevett, in Bull. ent. Res. *52*, has shown that prompt and regular harvesting of dry pods considerably reduced pre-harvest infestation by *Bruchidius* on cowpeas. An attempt was made in the present trials to confirm this effect locally on both cowpeas and grams and to assess the practicability of such treatment. Field staff were instructed to harvest according to two different regimes applied to replicate sub-plots. The régimes were not laid down precisely because local opinions as to what constituted "normal" practice varied considerably and an arbitrary pre-judgement of this seemed undesirable. The instructions issued were therefore that one series of sub-plots should be harvested according to practice while the other series should be harvested as frequently as was practicable but at least once per week and preferably twice per week. The actual interpretation of these instructions made it clear that at some stations "normal" practice was considered to entail fairly frequent harvesting while at other stations it was considered to mean harvesting the whole crop in one or two pickings. The harvesting pattern consequently varied considerably between sites but in all cases a comparison between "frequent" and "infrequent" (i.e. less frequent) harvesting was possible. The most distinct comparison was made at Mariakani where harvesting at 2-day intervals was considered feasible and was maintained regularly in comparison with two harvestings of the entire crop. The fact that this station had only cowpeas to contend with and three replicates instead of four is probably relevant in this context. The results of these comparisons, in terms of the percentage of harvested pods showing Bruchid infestation by the presence of eggs on the pods, are given in Table 3. The differentiation between infestation by *Bruchidius* and *Callosobruchus* is not shown here.

TABLE 3—MEAN NUMBER OF PODS PER CENT WITH BRUCHID INFESTATION AT HARVEST (Plot size: approximately 0·04 hectares)

Location	Replication	Number of harvests frequent/infrequent	Cowpeas frequent/infrequent	Grams frequent/infrequent
Mtwapa	×4	4*/2*	44·4/48·6	22·1/33·7
Mariakani	×3	8/2	2·2/30·8	—/—
Matuga	×4	6/3	12·1/15·8	22·9/28·3
Msabaha	×4	5/4	15·0/16·3	1·0/5·0

*Excluding 2 weeks irregular harvesting

The results show that frequent harvesting generally yielded fewer infested pods than infrequent harvesting but the differences obtained, excepting Mariakani, are unlikely to prove statistically significant and are hardly of practical significance whatever the statistical outcome. At Mariakani, where pods were harvested regularly at two-day intervals in the "frequent" treatment, the reduction in pre-harvest infestation was of practical significance but the advantage gained might be lost quite quickly unless the pods were disinfested soon after harvest. In the absence of effective control measures

the subsequent multiplication of the Bruchids in store, especially with *Callosobruchus*, would tend to obscure the initial difference and the terminal damage, after only a few months storage, could be much the same whatever the initial level. Estimates of the terminal damage after three months storage will be made to illustrate this point.

A simple trial to demonstrate the suitability of air-tight storage in coastal conditions for the disinfestation of cowpeas and grams, as an alternative to fumigation or the use of insecticide admixture treatments, has been set up using locally made steel containers (20 litre drums) with three different types of closure varying from a gasketed screw closure to a simple press-cap. All three types have been given effective control as compared with samples stored in ventilated jars where the ultimate damage level after five months storage was virtually 100 per cent. A complete comparison has still to be made. The germination of grams stored in these containers remained high (approximately 95 per cent after six days) after 3 months storage. It is noteworthy that the grams were not given special drying treatment and were at a moisture content in equilibrium with about 70 per cent r.h. which is probably representative of typical moisture levels, after normal sun-drying, at the Coast. The only detectable adverse effect of this treatment so far is a very slight mustiness which could be avoided by more thorough preliminary drying.

Two species of the Bruchid genus *Specularius* Bridw. have been recorded from pigeon peas grown at the Mtwapa Research Station. One of these, *S. impressithorax* (Pic.) has previously been recorded in East Africa from the seeds of *Erythrina* spp.; the other appears to be unrecorded previously and has been identified as *S. culcaticollis* (Pic.) by B. J. Southgate. Neither species was hitherto known as a pest of pigeon peas (*Cajanus cajan*) and it is likely that both occur as pre-harvest pests only. Further work on these beetles will be done if possible in relation to future investigations on pigeon peas next year.

Insect Damage to Stored Copra—J. A. McF.

This problem appears at present to be minor because of the current shortage of copra and the consequent rapid milling of the available supplies. If production increases again it could become a major problem where protracted storage is necessary and the basic solution to the storage infestation problem would be the full implementation of the Pieris recommendations for improved production methods and appropriate price incentives. Storage trials, including experimental insecticide treatments, will be undertaken if the supply situation improves. Work so far has been limited to observations on the incidence of infestation and it seems clear that copra delivered from most producers is normally free from infestation except for the beetle *Carpophilus*, which is a common minor pest in most rural areas, and that the full complex of copra pests build up only with protracted storage in urban stores and large plantation stores which are very few.

Insect Control Unit, Port of Mombasa—M. T. Locke

The Quarantine System continued to operate satisfactorily over the year. A comprehensive report on the work over the period 1965-1970 will be published elsewhere.

Stack Fumigation—R. W. Taylor

Cotton Seed Cake.—Following a test fumigation of a sheeted stack of maize in Mombasa in 1969 it was decided that such a test should be extended to other commodities. Post fumigation inspections of stacks of cottonseed cake at Mombasa frequently found that live insects, mainly *Tribolium castaneum*, were apparently surviving the fumigation, especially along the top edges of a stack. Chemical tests during commercial fumigations were then carried out to establish what CT products were being attained.

It has been customary to fumigate bagged cottonseed cake at Mombasa under gas-proof sheets using methyl bromide at a dosage rate of 4 lb. per 1,000 cu. feet This is the recommended dosage rate for the highly sorptive cottonseed cake. The cake is unloaded from rail trucks into go-downs before shipment, and since the cake is very

often of varying oil-content, single truck loads are frequently stored separately, each of about 25 tons and constructed from 190 lb. jute bags. As adjacent stacks are often not to be shipped together these small stacks are then fumigated singly or in groups of 2 or 3 or more.

A stack of 105 tons of bagged cottonseed cake was fumigated with methyl bromide under sheets at 4 lb. per 1,000 cu. ft. The fumigant was discharged from a branched piping system terminating in metal jets to facilitate distribution. During the discharge of gas a pressure of 90 lb. per sq. inch was maintained upon the cylinder. Gas concentrations were measured at intervals via capillary tubing previously inserted at four points in the stack. For the first twelve hours the concentration of fumigant at the points sampled was very uneven, the free space position near the floor being considerably higher than elsewhere. At this time the concentration had fallen to about 2.5 mg/l. and remained so until the end of the fumigation when at all points the concentration had reached 2 mg/l. Very little leakage was detected during the fumigation.

Another stack of 50 tons of cottonseed cake was fumigated using the same procedure. In order to verify if very local sorption was taking place around the jets, a sampling point was located in a bag, immediately adjacent to a jet. Another bag well away from any jets was sampled for comparison. After one hour the concentration of fumigant in the bag near the jet was 139 mg/l. while the in-bag position near the floor only showed a concentration of 19 mg/l. It was apparent that high local sorption was taking place around the jets, reducing very much the fumigant available elsewhere in the stack. These results of the two fumigations are shown in the table below.

FUMIGATION OF 105 TONS BAGGED COTTONSEED CAKE

Time interval	Position	1	2	3	4
2		6·5	6·0	5·5	30·0
4½		7·5	5·0	5·0	15·5
6½		7·5	4·5	4·5	12·0
12		4·0	3·0	3·0	3·5
22		3·5	3·0	3·0	3·0
26		3·0	2·5	2·5	2·5
30		3·0	2·5	2·5	2·5
48		3·0	2·5	2·5	2·5
Ct product for 48 hours			mg/l	methly	bromide
mg.h/l		140	130	130	260
		in-bag near edge of stack	in-bag middle of stack	in-bag near top of stack	free space near floor

FUMIGATION OF 50 TONS BAGGED COTTONSED CAKE

Time interval	Position	1	2	3	4
1		31·0	139·0	19·0	11·0
3		16·5	51·5	10·5	9·0
5		11·0	28·0	9·0	8·5
11		5·5	8·5	4·5	4·5
23		2·5	2·5	1·5	1·5
48		2·5	2·5	1·5	1·5
			mg/l	methyl	bromide
Ct product for 48 hours		160	830	170	140
mg.h. per 1		in-bag midway between top of stack and floor	in-bag near jet	in-bag near floor	free space on top of stack under sheet

Burns-Brown quotes a ct product of 125 mg/l. as being necessary to kill pupae of *T. castaneum*. In the fumigation of the 105 ton stack, this figure was only just reached at two locations where readings were taken. It is quite possible that some parts of the stack received lower ct products which could allow survival of pre-adult stages. The reason for this would seem to be due to very high sorption since even when a good piping system was used, and pressure was applied on the cylinder, the gas distribution was uneven.

In another series of tests no jets were employed in the piping system and pressure was not applied to the cylinder during gas discharge. Here the distribution of methyl bromide was very poor and over 48 hours the ct products at four locations in a 25 ton stack of bagged cottonseed cake were as follows:—

Position	*ct. product, mg h per* l	
Mid-way between top of stack and floor	137	
Near open end of jet ..	>1,500	(for the first 5 hours, reading off-scale on thermal conductivity meter).
In-bag position		
Near floor	125	
Free space on top of stack	75	

This test demonstrated that in fumigation cottonseed cake with methyl bromide under gas-proof sheets, the omission of jets in the piping system, and to a lesser extent the lack of pressure applied to the cylinder during gas discharge, could give very low ct products allowing pre-adult stages to survive.

As an alternative method of fumigating cottonseed cake, a stack of 75 tons was fumigated under sheets using phosphine. The fumigant was liberated from aluminium phosphide tablets and the dose used was six tablets per ton. Measurement of the gas concentrations was made at intervals by withdrawing samples through nylon capillary tubing into a bubbler apparatus. This apparatus allows the phosphine to react with a solution of mercuric chloride containing an indicator. The latter changes colour at a definite pH value when the end point is reached. The concentration of phosphine can then be read off a standard scale. The results are shown in the following table.

Time interval	*position*	1	2	3
6		0·30	0·30	0·30
22		0·60	0·65	0·70
26		0·95	0·95	0·95
30		0·90	0·90	0·90
48		0·60	0·65	0·60
72		0·30	0·30	0·30
			mg./l	phosphine

It can be seen from the figures above that the concentration of phosphine was quite even at all three locations, which were all within bags and as follows:—

1. On top of stack
2. Edge of stack between floor and top
3. Near floor

The ct product attained for the 72 hr. period of the fumigation was 40 mg.h./l.

Work elsewhere has suggested that a ct product of 10 mg.h./l. is sufficient to kill all stages of *T. castaneum* at 25°C, and with a minimum exposure period of two days. It would seem that in the test the required ct product would have been more than sufficient.

The temperature of this stack and all the cottonseed cake stacks tested at Mombasa was approximately 30°C. This factor would mean that a lower dosage of phosphine could be used while still obtaining sufficient ct products. The dosage of 6 aluminium phosphide tablets per ton would be more expensive than methyl bromide as far as the cost of fumigant is concerned. It was decided therefore to test a reduced dosage at four tablets per ton.

The only stack that was available consisted of 25 tons of bagged cottonseed cake. This stack was dosed and sheeted, but the proximity of an adjacent stack made sealing of the sheet to the floor along one edge very difficult. As a result considerable leakage of fumigant took place and the ct products recorded were low. The concentration in fact only reached a maximum of 0.5 mg./1. The ct product for the 72 hour period did exceed 10 mg.h./1 at all the four points sampled.

It has been suggested that leakage from a small stack is of more importance than from a large stack because of the small volume to periphery ratio in small stacks. For this reason it is suggested that in fumigating small stacks of cottonseed cake a higher dosage is used to allow for the greater possible leakage.

Following the tests on cottonseed cake in Mombasa it has been suggested that phosphine might replace methyl bromide as the fumigant. The exposure period should where possible be three days. For stacks of 25 tons or less a dose equivalent to 5 aluminium phosphide tablets per ton should be employed, and for larger stacks 3 tablets per ton may prove adequate; the tablets for convenience to be placed on trays.

Maize-germ meal.—Another commodity often fumigated for export at Mombasa is maize-germ meal. It was thought desirable to undertake a test of fumigation of this meal which is stored in bags and fumigated under gas-proof sheets using methyl bromide at 4 lb. per 1,000 cu. ft.

A 100 ton stack of meal was fumigated, nylon capillary sampling lines being previously inserted at four test sites. A few *T. castaneum* adults were observed in the stack and the temperature of the meal was 33°C. A conventional system of piping was placed on top of the stack and the piping outlets terminated in metal jets.

A pressure of 90 lb. per sq. inch was maintained upon the cylinder during gas discharge.

The stack was rectangular in shape and well built. Gas samples were measured using a thermal conductivity meter at intervals during the 48 hours of the fumigation. The results were as follows:—

Time interval	*position*	1	2	3	4
1		27·5	1·5	1·5	1·5
3½		21·0	7·0	4·5	5·5
5		18·0	9·0	6·0	8·5
11		15·0	13·0	8·5	13·0
22		12·0	10·0	8·0	10·0
28		8·0	7·5	7·5	8·0
48		6·0	6·0	6·0	6·0
			mg./1.	methyl	bromide
Ct product for 48 hours		540	410	340	400
hours mg./1					

in-bag position
1 Top of stack free space.
2 Near floor.
3 Near jet.
4 Two bags from nearest jet.

One hour after release of the methyl bromide the concentration within the bags where samples were taken, was only 1.5 mg./l. The concentration in the free space on top of the stack under the sheet was 27.5 mg./l. This indicated that either the penetration of gas into the very finely ground commodity was slow or that very high sorption was taking place. However the concentration in the bag near a jet was also very low and after hours the gas concentration in the bags had risen and after some 20 hours the fumigant was reasonably evenly distributed throughout the stack. Although there was sorption of the methyl bromide by the meal this was not sufficient to prevent more than adequate ct product being obtained over the 48 hour fumigation. The minimum ct product recorded was 340 mg.h./l.

This test demonstrated that fumigation of maize-germ meal in Mombasa, using methyl bromide at 4 lb. per 1,000 cu. ft., is very likely to give satisfactory results in controlling the common stored products insects infesting the meal.

Maize.—Research elsewhere has shown that the more resistant pre-adult stages of *Sitophilus zeamais* cannot be killed over a two-three day exposure period unless very high uneconomic dosage of phosphine are used.

If the exposure period is extended to 7 days or more, the development of the resistant insect stages continues during the fumigation until more susceptible stages are reached which succumb to much lower ct products. It was thought that use could be made of this dosage and extended exposure time in fumigating maize in a new store without gas-proof sheets. A full store was not available at the time but a stack of 16,000 bags of maize was made available by the Maize and Produce Board for fumigation under sheets. Use of phosphine for fumigating maize as an alternative to methyl bromide could prevent the build up of excessive bromide residues where a stack is fumigated several times.

The maize stack was situated in a corrugated iron store in Nairobi, the temperature of the maize bulk was 25°C. The phosphine for fumigation was derived from 1,920 aluminium phosphide tablets which were placed on trays. 14 trays were placed on the floor, and 6 were placed on top of the stack. The sheets which had been previously pulled onto the stack were then put into position and secured to the floor by using sand snakes. The dosage of fumigant used was a little over 1 tablet per ton and for convenience four large tins were employed.

During the course of the seven-day fumigation period phosphine concentration measurements were made at intervals by withdrawing samples through the capillary tubing into a bubbler apparatus for analysis.

Time interval hours	*Phosphine Concentration in mg/l Position*					
	1	2	3	4	5	6
5	0·20	0·20	0·48	0·49	0·49	0·52
23	0·62	0·52	0·85	0·75	0·75	0·75
30	0·82	0·82	0·92	0·92	0·97	0·95
50	0·85	0·85	0·90	0·87	0·97	0·97
71	0·65	0·70	0·75	0·75	0·75	0·72
95	0·50	0·52	0·55	0·50	0·52	0·52
119	0·40	0·42	0·42	0·42	0·42	0·38
143	0·27	0·28	0·33	0·30	0·27	0·27
167	0·20	0·20	0·20	0·20	0·20	0·20
Ct product mg.h/l ..	90	90	96	95	100	95

Position—1 Top, centre of stack in-bag.
2 Top ½–diagonal across to corner in bag.
3 Top corner of stack in-bag.
4 Corner of stack ½–way between floor and top in-bag.
5 Free space between bags, adjacent to position 4.
6 Corner of stack near floor in-bag.

The Bubbler Apparatus is only of limited accuracy and at the lower concentration levels of phosphine, such as at the end of the fumigation, the concentrations recorded are only approximate.

The ct products recorded during this trial were satisfactory and should have been sufficient to kill all stages of the Maize Weevil. An important factor is that a small concentration of fumigant remained in the stack even after 7 days exposure. The biossay tubes were removed from the stack as soon as the sheets were pulled back and all the adult weevils were dead. These insect cultures were then incubated at 25°C and 75 per cent alongside the control cultures. Large numbers of live adults continued to appear in the controls which were sieved every few days, indicating that pre-adult stages were present in the cultures when they were set up. In the fumigated insect cultures no live adults appeared over the five-week incubation period except in one culture where one adult appeared, two weeks after initial incubation, and another four weeks later. This culture had been in a biossay tube positioned near a bottom corner of stack. At this same location a gas-sampling point had recorded a ct product of 95 mg.h./l. which should have been sufficient to kill all stages of *S. zeamais*. Apart from this one location, all stages of the weevil were killed in the other insect cultures that were fumigated.

The fumigation of maize at a low dosage and extended exposure time was successful and is well worth consideration as an alternative to methyl bromide. It does mean that a stack must be left undisturbed for seven days which would not allow its use where the maize was required quickly. The survival recorded at one site does not agree with the chemical finding and could have been due to a fault in culturing techniques, or some failure of the gas to completely penetrate the biossay tube. The latter could have led to marginally lower ct products within the biossay tube.

IN-TRUCK FUMIGATION—R.W.T., M.T.L., J. A. McF.

It was found by the Storage and Infestation Control Survey at Mombasa that if rail-trucks containing produce for export, were taken direct into the port for loading without prior storage in Mombasa godowns, a saving of as much as K20/- per ton could be made. This saving was in storing and handling charges. Since produce infested by insects is prohibited from entering the island and nearby storage areas, a large proportion of the produce arriving at the Coast by rail is fumigated with phosphine in trucks while in transit.

Detailed inspection of produce is not allowed in the port and neither is fumigation. If therefore, produce is to be assigned to a ship as "nominated cargo", which is sent direct to the dockside transit sheds, an indicator of successful fumigation within the trucks would be most useful.

Such an indicator has been developed at the Pest Infestation Laboratory, Slough, and preliminary tests were initiated at the end of 1969. The indicator consists of a polythene sachet containing mercuric chloride solution and an indicator. The sachets change colour from violet to yellow when exposed to known ct product for phosphine at a defined temperature. Because the temperature is so important the sachets are placed within a truck at a site where the temperature variation is minimized, that is within the bulk of produce, between bags not against the metal walls of the truck, or on top of the produce where extreme ranges of temperature are experienced. The sachets were designed to change colour at a phosphine ct product of 85 ± 15 mg./l. at 25°C. At higher temperatures, the sachets will change colour more quickly due to increased rate of chemical reaction and the more rapid penetration of the polythene by the phosphine molecules.

Two series of in-truck fumigation trials using indicator-sachets were undertaken during the year, in both cases trucks being railed from Nairobi to Mombasa. In the first test three trucks containing wheat bran were fumigated commercially at a dosage rate of 10 tablets per ton being sealed in the usual manner with poly-foam strips. At two sites in each truck were placed a maximum/minimum thermometer, and a biossay tube containing live adult and pre-adult stages of *Sitophilus zeamais*. This insect was

used because it is known to be particularly resistant to phosphine in the pre-adult stages. An indicator-sachet was also at each site in the truck, the sachet being protected from damage by containing it in a rigid perforated polythene tube. In the second trial two trucks containing maize bran were tested in a similar way.

In the first trial the trucks were loaded and dosed under cloudy conditions and the temperature range recorded during the period until the trucks were opened was 20-25°C. The second set of trucks was loaded under much clearer weather conditions and also left standing in the siding for a time in the sun. This could be the reason for higher temperature range of 23-30°C being recorded during the trial. In the first series the indicator-sachets showed marginally adequate ct products for pre-adult *zeamais*. This was confirmed by the biossay in which there was a low survival of pre-adult stages even in the best truck.

In the second trial a good fumigation was suggested by the indicator-sachets, and this was also confirmed by biossay up to one week after incubation of the test material.

Plant Protection Services

Plant Inspection—O. J. Mbogo

No new legislation was enacted.

Import permits issued numbered 915. Export certificates issued numbered 450. Consignments intercepted both at the airport and the General Post Office, Parcels Section numbered 62.

Routine nursery inspection around Nairobi, Naivasha, Kibwezi and Thika areas was done. Flower export will in future be a very big revenue earner for the Republic and intensive inspection next year will have to be done to ensure good quality flower crop only is exported.

Only 6 fumigations were carried out (HCN 4, MeBr.2). The figure has previously been high because of orchid importers who failed to notify their shippers to comply with our regulations. During the year, the need to fumigate has been stressed to the importers and many have complied with the request thus reducing the number of fumigations.

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Mathez, F. C.—*Chilo partellus* Swinh., *C. orichalcociliella* Strand (Lep., Crambidae) and *Sesamia calamistis* Hmps. (Lep., Noctuidae) on maize in the Coast Province, Kenya. II-Biology (in Press).

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J. B. MUTHAMIA,
Senior Entomologist.

IV—COTTON RESEARCH SECTION

Nyanza and Western Province

Agronomy

General

At Kibos strong winds and heavy rainstorms caused serious reductions in yield. The mean yield of all trials was 1,259 kg. seed cotton per hectare, the lowest since 1962. At Busia, where in the past it has been difficult to obtain good yields of cotton, recent extensive lime and fertilizer applications have increased yields considerably and the mean yield from all experiments was 1,411 kg. per hectare.

Maximum yield plots at Kibos and Busia

The yield of this plot at Kibos was only 1,404 kg. seed cotton per hectare which was less than half that in the previous year. This is a reflection of the bad weather as the plot was early sown, clean-weeded, fertilized with 400 kg. sulphate of ammonia per hectare and sprayed regularly. At Busia half the maximum yield plot received lime and other fertilizers and normal good cultural treatments including pest control. The half of the plot which has received no additional fertilisers since 1960 gave a yield of 1,736 kg. seed cotton per hectare. The other half of the plot receiving fertilizer in 1970 yielded 2,593 kg. per hectare. These are the highest yields ever obtained at Busia and it is unfortunate that closure of the station does not permit a continuation of this investigation.

Demonstration plots at Kibos

It was again demonstrated that early sown but unsprayed cotton gave no more and in this season considerably less cotton than late sown unsprayed cotton. This once more emphazises the need to couple insecticide protection with early sowing. If early sowing is encouraged without the proper control of pests the farmer may be worse off than if he sows late.

Interplanting of cotton and other crops

This observation was only made at the specific request of the extension staff. The results could not be analysed statistically but there was an indication that alternate double rows of cotton and maize may give yields which are comparable with pure stands of each crop. A statistically designed experiment will be sown next season.

Cost of production plots

This is a continuation of the study started last season and is similar to that conducted at the Coast Station, Msabaha for several seasons. The object is to try and gain more accurate values of the cost of production of cotton by the farmer if he carries out all the recommended practices. The value of cotton grown on ridges was Sh. 1,112 per hectare. Cost of labour was Sh. 665 and insecticide Sh. 148 giving a total cost of Sh. 813. The profit was Sh. 299 per hectare. However if one assumes that labour is supplied by the family the total profit becomes Sh. 964 per hectare.

Weeding experiments at Kibos

The object of these experiments was to determine the optimum time and frequency of weeding. The critical period of weeding was between 20 and 40 days after sowing. Further delay decreased yields due to competition for water and nutrients by the weeds. The overall profit was greater if weeding was continued until 60 days although the profit per unit of labour decreased during the latter period.

In the second experiment plots were weeded at intervals of 1, 2, 3 and 4 weeks. It appeared that it was not necessary to weed more frequently than every 4 weeks but obviously this will depend on the degree of weed cover in any situation. It would probably be better to advocate more frequent weeding in the hope that the actual interval in practice was adequate.

Herbicides

In trials of a whole range of herbicides the two which had been promising in previous years i.e. monuron and diuron, again gave both economic and effective weed control if the isolated weeds which escaped were controlled by hand. Prometryne gave excellent weed control but the yield of cotton was affected. Nitralin was also promising but gave poor control of broad-leafed weeds. It must be emphasized that these results are specific to the heavy clays of Kibos and the Kano Plains area.

At Busia none of the herbicides tested gave adequate weed control on their own.

ENTOMOLOGY

Time of sowing and spraying

Cotton sown in the short rains compared to the more usual long rains cotton was not successful this season. It appeared that growth was continuous throughout the January-February period as a result the pest build up in this cotton was severe. It is possible to get a very good crop of cotton in the long rains alone and it is doubtful if one should further investigate a system which leads to continuous cotton similar to that in Eastern Province with its associated dangers of encouraging pink bollworm.

At Busia an experiment to test the new spraying regime (DDT x 5 followed by Sevin x 5 at 7 day intervals, starting 70 days after sowing), showed that this regime was very much better than that previously recommended of DDT+Sevin sprayed five times at 10-day intervals. The extension of the spraying period and particularly the late sprays of Sevin gave better control of stainers.

Insecticide with molasses

A trial in which various insecticides with the addition of molasses were compared with the standard DDT-Sevin regime, gave inconclusive results. However the addition of molasses certainly caused higher mortality of moths but overall yields of seed cotton were not better than the standard treatment. There is need to investigate this aspect further.

Eastern and Central Provinces

Time of sowing

At Giaki (Meru) and Wanguru (Kirinyaga), time of sowing experiments were continued to investigate the importance of early sowing. At Giaki a range of sowing dates from 7th October to 2nd December showed no influence on final yield. This is in accord with previous results. In this area it is best to advise farmers to sow in the first two weeks of November. This is a compromise which allows sufficient rain for establishment and reduce excessive vegetative growth.

At Wanguru there was a decrease in yield with each date of sowing after mid-October. The biggest decrease occurred when cotton was sown later than 7th November. There is no doubt that at this station and others further south, the earlier the cotton is sown in the short rains, the better is the yield obtained.

Interplanting with beans

An experiment was made at Giaki and Wanguru to test the effect of interplanting cotton with beans. Cotton was sown at the recommended row spacing of one metre with a single row of beans midway between rows. The beans were two varieties at two spacings.

At Giaki the beans did not affect the cotton yield and the mean yield of beans was 675 kg. per hectare. Earlier sown beans gave a higher yield than late sown.

At Wanguru the beans depressed the yield of cotton although the local beans caused a smaller decrease than the M 142 variety. The yield of beans was poor, an average of only 263 kg. per hectare. Once again late planted beans gave lower yield than early planted.

It is probable that this system of farming will only be profitable in the wetter areas such as Meru.

Spacing

A number of different spacing treatments are being investigated to find a method of growing cotton which gives easier access to the crop for the purposes of spraying. This season none of the treatments gave significantly different yields to the standard one metre rows. However spacing two rows at 0.5 metre with a gap of 1.5 m. to the next pair of rows gave no decrease in yield of cotton and allowed freer passage within the crop later in the season.

Cultivations

In the drier areas of Kitui and Machakos an experiment was made to investigate the effect of growing cotton on ridges and on the flat. The experiment at Kitui was inconclusive due to frequent grazing of the plants by local animals. At Machakos the cotton grown on ridges gave a yield of 881 kg. seed cotton per hectare compared with 690 kg. on the flat. This was in an exceptionally dry year so this cultivation should be further investigated as it may increase yields in years with insufficient rainfall.

J. K. BROWN,
Senior Cotton Research Officer.

NATIONAL AGRICULTURAL RESEARCH STATION, KITALE

I—MAIZE RESEARCH SECTION

A.—Review of the Year

In general the long season areas of Western Kenya, where the late maturity maizes are grown had a good maize growing year in 1970. The rains started promptly in February/March and were well distributed during the major part of the growing season. Kakamega received a total of 2319.5 mm. which was 158 per cent of the annual average. Kitale also exceeded the average annual rainfall. Excessive rainfall and stormy weather during the latter part of the year caused much lodging and cob rot.

In Eastern Kenya where there are two maize growing seasons, the long rains were below normal. The second, short rainy season, was very much below normal and in many parts there was a complete failure with no crops coming to harvest. The following tables of rainfall of selected stations of interest summarize the weather position in 1970.

TABLE WR/1—N.A.R.S., KITALE (Alt. 1,860 m) RAINFALL, 1970

Month	Rainfall (mm)	No. of wet days
January	105·7	15
February	8·7	2
March	226·4	15
April	198·7	17
May	135·7	19
June	328·3	14
July	177·3	21
August	214·1	29
September	86·1	18
October	82·7	19
November	32·4	9
December	13·6	4
TOTAL	1,609·7	182

TABLE WR/2—KATUMANI STATION (Alt. 1575 m) AND KAMPI YA MAWE (Alt. 1,110m) RAINFALL 1970. (TWO MAIZE GROWING SEASONS)

Month	KATUMANI		KAMPI YA MAWE	
	Rainfall (mm)	No. of wet days	Rainfall (mm)	No. of wet days
January	135·8	7	34·7	5
February	0	7	88·2	9
March	101·9	5	90·4	15
April	137·8	10	35·6	4
May	84·8	7	32·8	3
June	1·0	1	4·3	1
July	1·6	1	0·0	0
August	4·3	1	15·0	1
September	0	0	0·0	0
October	0	0	28·4	7
November	34·0	8	184·7	19
December	59·8	4	31·7	8
TOTAL	560·2	44	545·8	72

TABLE WR/3—EMBU STATION (Alt. 1,440 m) RAINFALL 1970. (TWO MAIZE GROWING SEASONS)

Month	Rainfall (mm)	Percentage of the monthly average
January	72·7	341
February	0	0
March	140·4	144
April	138·2	85
May	94·2	57
June	15·8	54
July	50·8	106
August	57·1	133
September	150·4	424
October	55·5	28
November	202·6	73
December	39·1	45
TOTAL	1,016·8	86%

B.—Report on Experiments

SECTION I: METHODS OF BREEDING RESEARCH—L. H. PENNY AND C. M. NDEGWA

(a) Maize Breeding Method Study (MBMS)

Seventeen different selection experiments were initiated in 1964 to determine the most efficient breeding method for lesser developed countries which had had no previous maize research programmes. Studies were undertaken in Kitale II (KII), Ecuador 573 (Ec.573); and Kitale Composite A (KCA) which was derived from random mating the cross KII x Ec.573. Breeding methods under evaluation are ear-row selection, mass selection and recurrent selection. Within the general class of recurrent selection are S_1 line selection, half-sib selection, full-sib selection and reciprocal recurrent selection. Studies within types of breeding methods differ by material, plant population, selection intensity, number of cycles of random mating, selection among males, number of entries, and tester. Figure 1 outlines the current breeding programme.

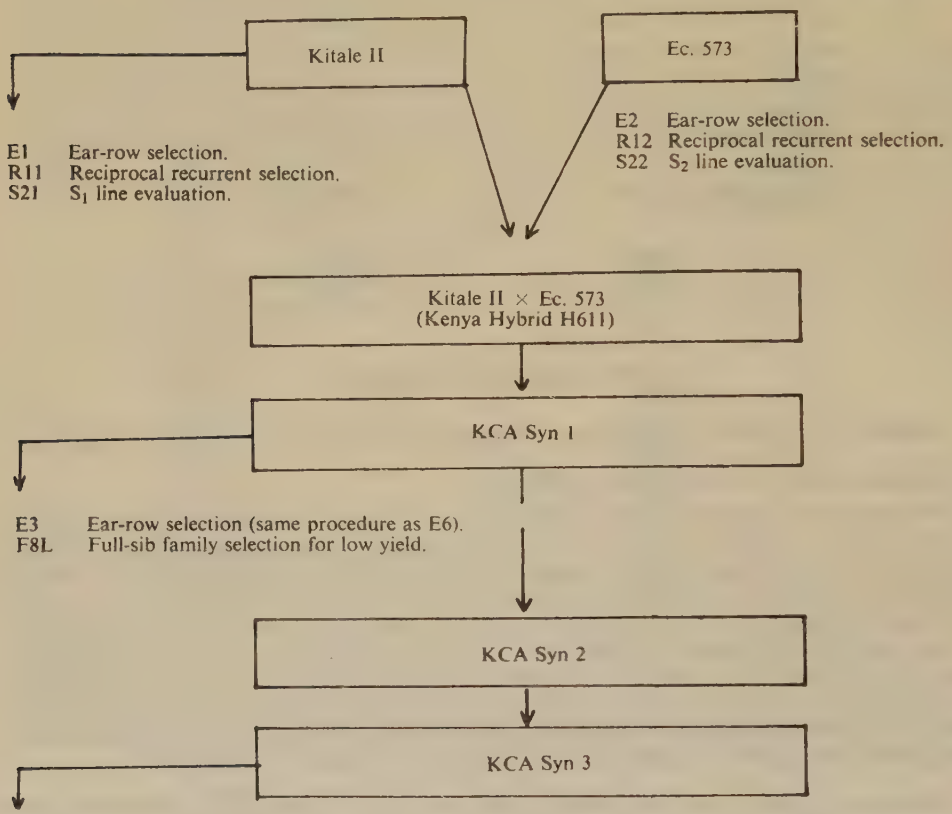
Two new studies have been started since March 1970. KCA(M17) was grown for the first time in the 1970 yield trials. M17 consists of a mass selection programme with 10 per cent selection intensity at a low plant population (23,438 plants per ha). M17C0 was taken from a bulk of M10C5. When compared to M10 it will provide information on the effect of plant populations in mass selection programmes. S22, which is S_1 line selection in Ec.573, was initiated in August 1970 with the first yield trials of S_1 lines in 1971. In 1971, S21 will be started in KII to complement S22. These will provide a comparison to the ear-row selection method (E1, E2) and to reciprocal recurrent selection (R11, R12). The details of the 1970 trials are not presented here but are otherwise summarized in Table BMS/1 which also shows the estimates of variance components heritabilities (H), selection differential (D), and the expected gain from each cycle of selection. Heritability was calculated as—

$$\frac{s^2_g}{s^2_{ph}} \quad \text{where} \quad s^2_{ph} = \frac{s^2_e}{rl} + \frac{s^2_{ge}}{l} + s^2_g.$$

In these equations s^2_g is the genotypic variance due to entry differences; s^2_e is the error variance; s^2_{ge} is the genotype x environment interaction and l and r are the number of locations and replications within locations, respectively. Expected gain was computed as $\frac{1}{2}HD$ for the ear-row and S_1 line selection experiments and HD

for the remainder (F8L, H14, HL15). The pooled error was calculated by averaging errors from each location. Expected genetic mean squares are shown below:—

Source of Variation	*Genetic EMS*
Entries	$s^2_e \times rs^2_{ge} \times rls^2_g$
Loc. x Entries	$s^2_e \times rs^2_{ge}$
Pooled error	s^2_e



EAR-ROW SELECTION

E4 23,438 plants/ha., no selection among males, 49 entries.
E5 46,876 plants/ha., no selection among males, 49 entries.
E6 46,876 plants/ha., 50% selection among males, 49 entries.
E7 46,876 plants/ha., 50% selection among males, 100 entries.

MASS SELECTION

M9 2% selection intensity, 46,876 plants/ha.
M10 10% selection intensity, 46,876 plants/ha.
M17 10% selection intensity, 23,438 plants/ha.

RECURRENT SELECTION

S13 S_1 line evaluation.
H14 Testcross evaluation, parent population tester.
HL15 Testcross evaluation, low yield population (F8L) tester.
H116 Testcross evaluation, inbred line tester.
F18 Full-sib family selection.

Figure 1. Outline of Maize Breeding Method Study.

KII(E1) at Kitale had only one replication harvested due to spray damage in the second replication. When s^2_{ge} was computed it was negative by a large margin and was assumed to be zero. Similarly in KCA(E4) the pooled error mean square was larger than the location x entry mean square and s^2_{ge} was assumed to be zero.

Among the ear-row experiments KCA(E4) was predicted to have the largest gain (5 per cent). Other ear-row predicted gains ranged down to 3.3 per cent. KCA(F8L) was predicted to decrease in yield by 11 per cent and KCA(S13) to increase by a like amount.

Selection differentials (D) were at new highs in KCA(E4), KCA(E7), KCA(F8L) and KCA(H15). Heritabilities (H) were unremarkable when compared to previous years. No trends could be discerned in s^2_g or s^2_{ge}.

Experiment KCA(F8L) did not have "plants with ears" data taken at Kakamega. The analyses were computed two ways for comparison. In one method the Kakamega location was simply omitted and in the second the analysis was done using "Method 3" for Kitale, Endebess, and Njoro and "Method 0" for Kakamega. "Method 3" utilizes a correction for barren plants (low yielding plants are desired rather than selection for barrenness) whereas "Method 0" does not. When the combined means were compared for selection it was found that nine of the top ten by each method were in common. In order to keep the estimates of genetic parameters clean and in view of the low influence of Kakamega, data presented in Table BMS/1, do not include that location.

(b) Breeding Method study and KCE Combining Ability Evaluations

Experiment 024 was designed to contrast progress from selection among several breeding methods and to evaluate the performance of KCE in combination populations from the Breeding Method Study. Yields from individual locations are presented in Table BMS/2, and agronomic attributes are in Table BMS/3. Stands were satisfactory

TABLE BMS/1—ESTIMATES OF VARIANCE COMPONENTS, HERITABILITIES (H) SELECTION DIFFERENTIALS (D), AND EXPECTED GAIN FROM EACH CYCLE OF SELECTION

Expt.	Year	Mean Yield	s^2_e	s^2_{ge}	s^2_g	H	D	Expected Gain q/ha	Expected Gain %
E1 ..	1964	48·1	137·38	16·96	13·14	·38	10·3	1·96	4·1
	1965	44·1	63·31	7·08	27·72	·74	9·5	3·52	8·0
	1966	60·1	96·65	33·08	15·52	·43	10·6	2·28	3·8
	1967	44·1	137·54	34·89	0·00	·00	7·6	0·00	0·0
	1968	54·3	123·56	27·57	13·33	·37	10·9	2·02	3·7
	1969	67·0	140·76	38·74	0·13	·00	8·6	0·00	0·0
	1970	47·4	154·93	0·00	10·97	·33	9·5	1·57	3·3
E2 ..	1964	50·6	118·95	23·75	71·20	·77	17·7	6·81	13·5
	1965	38·9	63·68	30·86	13·52	·46	9·8	2·25	5·8
	1966	53·6	90·66	10·93	23·24	·62	10·8	3·35	6·2
	1967	33·5	61·10	24·71	18·76	·58	10·0	2·90	8·7
	1968	46·8	99·98	4·35	10·46	·43	9·6	2·06	4·4
	1969	63·0	107·79	7·06	21·54	·51	10·4	2·65	4·2
	1970	54·8	122·46	6·77	17·04	·50	10·3	2·58	4·7
E3 ..	1964	49·0	167·71	24·86	36·84	·58	13·3	3·86	7·9
	1965	45·7	87·74	23·38	6·36	·27	7·1	0·96	2·1
	1966	53·4	79·49	15·74	15·59	·53	10·0	2·65	5·0
	1967	43·3	99·01	31·64	32·73	·62	12·3	3·81	8·8
	1968	51·6	113·73	35·70	13·47	·37	8·9	1·65	3·2
	1969	66·7	129·35	28·85	17·88	·36	10·1	1·82	2·7
	1970	55·1	101·38	36·53	17·57	·45	8·6	1·92	3·5

TABLE BMS/1—(*Contd.*)

TABLE BMS/1—ESTIMATES OF VARIANCE COMPONENTS, HERITABILITIES (H) SELECTION DIFFERENTIALS (D), AND EXPECTED GAIN FROM EACH CYCLE OF SELECTION

Expt.	Year	Mean Yield	s^2_e	s^2_{ge}	s^2_g	H	D	Expected Gain q/ha	Expected Gain %
E4 ..	1965	32·3	21·18	8·31	8·06	·63	5·6	1·76	5·5
	1966	37·4	29·55	4·89	7·48	·60	4·4	1·32	3·5
	1967	33·8	34·55	6·16	7·66	·57	6·6	1·88	5·6
	1968	46·0	42·56	18·73	6·21	·38	7·6	1·44	3·1
	1969	48·9	34·53	9·30	3·42	·28	6·5	0·91	1·9
	1970	52·4	76·77	0·00	12·92	·57	9·2	2·64	5·0
E5 ..	1965	38·7	75·37	16·65	10·62	·44	7·0	1·54	4·0
	1966	45·4	90·17	7·62	16·06	·55	8·5	2·34	5·2
	1967	50·3	66·03	40·12	9·65	·35	9·0	1·58	3·1
	1968	49·1	100·28	43·29	12·81	·35	10·8	1·89	3·8
	1969	59·4	119·80	3·45	23·98	·53	12·2	3·23	5·4
	1970	57·5	91·39	24·17	13·39	·42	9·8	2·08	3·6
E6 ..	1965	38·3	57·62	21·02	12·78	·51	7·7	1·96	5·1
	1966	52·1	126·72	11·18	9·03	·33	8·9	1·47	2·8
	1967	50·7	135·23	12·26	12·84	·39	10·1	1·97	3·9
	1968	50·7	69·44	40·46	0·00	·00	7·7	0·00	0·0
	1969	53·8	134·71	19·22	29·68	·51	13·3	3·39	7·2
	1970	62·0	109·42	8·14	21·45	·58	9·3	2·68	4·3
E7 ..	1965	41·7	69·21	26·02	29·20	·66	11·0	3·63	8·7
	1966	57·2	95·52	14·26	18·07	·54	10·0	2·70	4·7
	1967	43·4	94·04	35·78	9·56	·32	9·2	1·47	3·4
	1968	61·8	109·61	35·62	36·23	·62	10·7	3·32	5·4
	1969	59·5	134·34	32·27	19·52	·37	10·3	1·91	3·2
	1970	62·5	131·35	24·71	12·85	·36	11·2	2·03	3·3
E8L ..	1964	61·0	51·53	9·09	5·86	·25	—9·1	1·14	1·9
	1965	43·7	19·01	4·60	6·17	·47	—5·2	1·23	2·8
	1966	44·5	36·83	4·26	21·10	·65	—7·9	2·57	5·8
F8L ..	1968	52·8	73·92	23·83	19·40	·66	—8·1	5·35	10·1
	1970	54·0	99·05	27·65	20·21	·44	13·5	5·94	11·0
R11 ..	1965	52·4	93·05	29·82	7·37	·28	8·6	2·41	4·6
	1967	62·0	133·29	19·08	6·06	·22	8·4	1·85	3·0
	1969	70·1	162·94	19·73	10·26	·23	8·4	1·93	2·8
R12 ..	1965	52·4	102·38	31·04	15·96	·44	10·6	4·66	8·9
	1967	59·0	147·25	28·34	30·11	·54	11·3	6·10	10·3
	1969	71·5	151·85	13·10	3·38	·10	8·9	0·89	1·2
S13 ..	1966	33·7	55·55	26·54	47·95	·78	14·5	—	—
	1968	35·8	59·67	30·31	74·31	·83	15·9	—	—
	1970	36·8	75·07	27·65	35·92	·70	11·5	4·05	11·0
H14 ..	1966	57·7	119·74	4·30	12·11	·43	10·6	4·56	7·9
	1968	64·2	86·86	21·17	14·46	·47	8·9	4·18	6·5
	1970	63·4	148·31	5·37	12·22	·38	10·2	3·88	6·1
HL15 ..	1966	57·1	116·04	17·02	13·08	·41	9·6	3·94	6·9
	1968	55·3	134·00	8·72	22·26	·54	9·6	5·18	9·4
	1970	57·4	141·16	22·31	11·64	·33	10·1	3·37	5·9
H116 ..	1967	54·5	116·42	14·91	34·30	·58	12·7	7·37	13·5
	1969	51·6	106·63	21·02	26·78	·52	11·6	6·03	11·7
F18 ..	1967	43·6	124·55	28·97	15·56	·41	11·7	4·80	11·0
	1969	60·2	133·22	30·70	42·25	·57	14·1	8·04	13·4

and no covariance with stand was run (difficulties were encountered with regression coefficients greater than one or negative). By any standards lodging was excessive as two-thirds of the plants were lodged. Only small differences were found in days to tassel but it is noteworthy that H.613C was one of the earlier entries. The earliest was SR.52 x Ec.573(R12)C2. Ear heights were tremendous, all entry means were above 200 cm. and 16 of 36 were above 250 cm. The lowest by 17 cm. was H.632. Next was SR.52 x Ec.573(E2)C4 which was also one of the earliest. A SR.52 topcross trial is to be grown in 1971 so as to determine the value of SR.52 in combination with some of the current populations.

H.611 (R)C0, C1, C2 were grown for comparison of hybrid improvement with combined yields of 54.8, 64.5 and 69.0 q/ha. The increment from C0 to C1 is statistically significant at the .05 probability level and the improvement from C1 to C2 while not statistically significant still represents a 7 per cent increase in yield. The commercial version of H.611, H.611C, yields 69.2 q/ha which was essentially the same as our H.611(R)C2(69.0).

The comparison in H.613 is similar but not as extensive. H.613B yielded 54.9 q/ha and the improved version H.613C yielded 68.2 q/ha. The increase is significant and is an average increment of 12 per cent per cycle.

Hybrid analogues using Ec.573(E2)C4 instead of Ec.573(R12)C2 were grown. In all comparisons the ear-row population yielded substantially less (range: 10.4 to 3.3 q/ha, mean difference of six comparisons: 7.3 q/ha) than the reciprocal recurrent selection population.

SR.52 x Ec.573(R12)C2 yielded highest in the test and also was among the earliest and shorter entries. Some production difficulties were indicated by the Kenya Seed Company; however a full discussion of this matter is forthcoming.

KCE did well when crossed to KCA(HL15)C2 and KCA(H14)C2, yielding 59.4 and 57.6 q/ha respectively. The poorest results were from KCE x Ec.573C0 and KCE x KCA(E4.7)C0. Little difference was found between KII, Ec.573, or KCA populations as a whole.

It was noted that there was a wide range of locations as evidenced by the large spread of location means. Usually high C.V.'s for Busia and Kakamega were due more to a lower mean than any increased error variance.

Plant populations were 46,876 plants per hectare in 22 plant plots with 80 cm. between rows and 26.7 cm. between plants.

(c) Eastern African Maize Variety Trials

Data were compiled and a report issued in May of 1970 on the 1968-1969 E.A.M.V.T. Seven countries successfully grew the trial in 1968-1969. Twenty-five entries were grown and data were taken for yield stand, lodging, bare tips ear per 100 plants, diseased ears, days to tassel, ear height, blight score, and rust score. Table BMS/4 shows the mean yields in quintals per hectare for the Kenya location and this is divided into two levels of altitude.

In Kenya and Ethiopia, H.611(R)C1 yielded better than other hybrids. Of the composite entries UCA faired best in the same areas. SR.52 was tops in Malawi, Uganda, Zambia, and higher elevations of Tanzania. UCB-W did well in many countries particularly the Camerouns where it was second only to H.632. Generally the hybrids outyielded the composite varieties. No general conclusion may be drawn relating the composite varieties to the composite crosses.

No E.A.M.V.T. was held for the 1969-1970 season as there was not enough new

TABLE BMS/2—YIELDS (q/ha) OF SELECTED CROSSES FROM THE BREEDING METHOD STUDY AND COMBINING ABILITY EVALUATION OF KCE, GROWN AS EXPERIMENT 24 OF 1970

PEDIGREE	1	2	3	4	5	6	7	8	9	10
KII CO x Ec. 573 CO	62·0	67·6	41·5	82·1	56·4	60·4	82·0	13·5	61·4	58·5
KII CO x Ec. 573 CO	30·2	49·9	28·3	83·6	55·5	68·6	76·9	16·2	50·5	51·1
KII (R11) C1 x Ec. 573 (R12) C1	72·2	67·8	35·2	91·7	67·4	76·8	94·4	22·8	51·9	64·5
KII (R11) C2 x Ec. 573 (R12) C2	84·3	74·4	55·7	103·8	67·5	63·5	89·6	9·4	72·3	69·0
KII (R11) C2 x Ec. 573 (E2) C4	62·6	57·3	55·4	86·8	68·9	66·1	77·5	11·2	56·8	60·3
KII (E1) C4x Ec. 573 (R12) C2	56·2	66·4	48·0	100·5	54·1	70·4	86·6	16·3	75·5	63·8
KII (E1) C4x Ec. 573 (E2) C4	71·3	81·4	137·1	85·0	67·6	68·9	75·4	13·3	44·6	60·5
KIII x Ec. 573 (R12) C2	69·7	79·1	51·9	91·2	71·2	78·0	96·3	13·1	71·9	69·2
KIII x Ec. 573 (E2) C4	75·1	60·4	29·2	87·6	55·0	66·9	97·7	16·6	63·2	61·3
SR. 52 x Ec. 573 (R12) C2	101·7	73·9	53·0	94·0	64·0	83·1	81·1	17·8	70·2	71·0
SR. 52 x Ec. 573 (E2) C4	77·1	58·9	45·4	87·9	60·9	55·2	75·2	17·6	67·3	60·6
(F x G) x Ec. 573 CO	69·3	55·6	43·1	77·2	57·5	64·0	53·5	19·6	54·2	54·9
(F x G) x Ec. 573 (12) C2..	79·5	62·9	46·5	93·8	69·6	75·9	89·5	13·6	78·2	68·2
(F x G) x Ec. 573 (E2) C4	54·3	60·9	42·3	95·2	60·7	65·9	57·4	13·1	74·2	58·2
KCE x KII CO	50·7	50·3	43·9	69·0	51·0	57·2	54·0	13·1	53·5	49·2
KCE x KII CO	51·2	38·8	38·7	72·4	55·5	57·7	55·7	14·2	53·7	48·7
KCE x KII (R11) C2	70·1	48·9	26·6	74·0	54·6	55·4	73·2	23·9	48·1	52·8
KCE x KII (E1) C4	63·4	39·5	31·1	78·9	51·0	56·7	54·0	20·9	49·0	49·4
KCE x Ec. 573 CO	48·9	47·8	23·9	69·9	47·6	49·0	74·5	8·2	44·2	46·0
KCE x Ec. 573 CO	46·5	48·5	16·4	67·3	47·3	60·3	66·7	14·4	51·2	46·5
KCE x Ec. 573 (R12) C2	65·1	48·5	31·1	85·7	51·2	57·2	83·6	18·0	66·5	56·3
KCE x Ec. 573 (E2) C4	61·4	53·9	27·0	78·4	50·8	56·3	91·4	20·3	35·5	52·8
KCE x KCA (E4—7) CO	45·2	44·8	27·4	86·0	42·4	53·9	44·5	18·6	36·4	44·3
KCE x KCA (E4—7) CO	55·4	49·4	36·6	73·4	50·2	48·6	72·9	14·1	36·0	48·5
KCE x KCA (E3) C4	58·1	42·3	35·1	76·0	50·0	61·2	65·2	16·8	55·3	51·1

TABLE BMS/2—YIELDS (q/ha) OF SELECTED CROSSES FROM THE BREEDING METHOD STUDY AND COMBINING ABILITY EVALUATION OF KCE, GROWN AS EXPERIMENT 24 OF 1970—(*Contd.*)

PEDIGREE	1	2	3	4	5	6	7	8	9	10
KCE x KCA (E4) C4	50·8	39·3	28·3	74·5	41·6	53·5	75·6	19·3	50·5	48·1
KCE x KCA (E5) C4	61·4	48·8	27·7	73·3	50·1	55·7	63·2	16·3	50·7	49·7
KCE x KCA (E6) C4	56·6	54·3	30·9	74·4	49·4	55·4	65·4	13·2	61·1	51·2
KCE x KCA (E7) C4	52·8	49·9	36·4	70·7	43·7	55·4	71·8	22·9	51·9	50·5
KCE x KCA (M9) C4	53·8	44·1	25·1	80·4	40·9	50·0	69·0	12·6	44·2	46·7
KCE x KCA (M10) C4	63·7	47·7	29·6	82·3	52·5	56·6	71·0	21·0	43·0	51·9
KCE x KCA (S13) C2	56·5	54·7	29·0	69·0	51·1	48·9	67·3	15·6	57·5	50·0
KCE x KCA (H14) C2	56·3	44·4	44·6	101·7	51·0	63·2	83·5	9·9	63·7	57·6
KCE x KCA (HL15) C2	67·0	59·3	40·2	97·7	57·2	59·0	77·8	27·3	49·2	59·4
KCE x KIII	76·2	61·9	37·9	84·8	54·8	57·8	61·8	15·7	61·7	56·6
H. 632 Commercial	35·9	44·7	49·3	72·4	30·4	49·0	67·6	26·3	38·4	46·0
Mean	61·4	54·9	36·9	82·7	54·2	60·6	73·4	16·6	55·4	55·1
L.S.D. 05	24·9	18·0	20·7	17·6	14·0	18·8	25·3	11·8	22·8	7·5
CV %	24·8	20·0	34·3	13·0	15·8	19·0	21·1	43·7	25·2	—

1=Kitale N.A.R.S.
2=Endebess Strong Farm.
3=Kakamega.
4=Njoro.
5=Kitale Top Station.
6=Endebess Kenya Seed Company.
7=Mt. Elgon Chorlim Farm.
8=Busia.
9=Kitale N.A.R.S. (Late).
10=Mean.

TABLE BMS/3—COMBINED MEANS FOR YIELD AND OTHER AGRONOMIC ATTRIBUTES OF SELECTED CROSSES FROM THE BREEDING METHOD STUDY AND COMBINING ABILITY EVALUATION OF KCE GROWN AS EXPERIMENT 24 OF 1970. (NUMBER OF LOCATIONS ARE SHOWN IN PARENTHESES).

PEDIGREE	Yield q./ha. (9)	Stand % (9)	Lodging % (8)	Bare tips % (9)	Usable ears % (9)	Diseased Ears % (9)	Days to tassel (7)	Ear height (cm.) (5)
KCE x Ec. 573 (R12) C2	56·3	98·1	60·4	15·4	74·0	5·2	107·5	260·3
KCE x Ec. 573 (E2) C4	52·8	97·8	74·5	24·9	71·3	7·1	108·4	258·7
KCE x KCA (E4—7) CO	44·3	98·8	71·1	22·3	61·5	8·9	107·9	252·0
KCE x KCA (E4—7) CO	48·5	98·1	77·1	18·8	65·4	6·3	107·2	256·1
KCE x KCA (E3) C4	51·1	97·5	64·6	21·8	70·2	5·3	107·5	252·0
KCE x KCA (E4) C4	48·1	97·8	62·7	21·3	68·4	8·2	107·6	252·9
KCE x KCA (E5) C4	49·7	99·3	62·3	21·8	64·9	7·8	107·5	256·9
KCE x KCA (E6) C4	51·2	98·0	63·0	24·0	68·3	5·3	107·9	247·7
KCE x KCA (E7) C4	50·5	98·1	67·2	26·1	68·9	7·6	105·9	242·3
KCE x KCA (M9) C4	46·7	98·1	65·7	23·0	65·1	8·6	109·0	255·6
KCE x KCA (M10) C4	51·9	97·3	65·8	18·1	67·0	7·7	107·2	247·0
KCE x KCA (S13) C2	50·0	96·6	67·2	22·4	71·3	6·2	106·3	238·9
KCE x KCA (H14) C2	57·6	99·5	60·7	20·5	72·5	5·9	105·9	239·2
KCE x KCA (HL 15) C2	59·4	99·2	63·5	23·1	76·4	8·1	105·7	238·7
KCE x KIII	56·6	97·8	74·3	21·5	74·5	7·6	106·7	239·4
H.632 Commercial	46·0	99·0	81·7	18·0	70·5	16·3	103·0	203·2
Mean	55·12	98·23	67·57	21·32	71·94	6·87	106·15	246·31
L.S.D. 05	7·50	1·60	—	7·87	7·49	4·11	—	—

TABLE BMS/3—COMBINED MEANS FOR YIELD AND OTHER AGRONOMIC ATTRIBUTES OF SELECTED CROSSES FROM THE BREEDING METHOD STUDY AND COMBINING ABILITY EVALUATION OF KCE GROWN AS EXPERIMENT 24 OF 1970. (NUMBER OF LOCATIONS ARE SHOWN IN PARENTHESES).—(*Contd.*)

PEDIGREE	Yield q./ha. (9)	Stand % (9)	Lodging % (8)	Bare tips % (9)	Usable ears % (9)	Diseased Ears % (9)	Days to tassel (7)	Ear height (cm.) (5)
KII CO x Ec. 573 CO	58·5	98·5	64·2	19·5	72·0	5·1	106·5	252·5
KII CO x Ec. 573 CO	51·1	97·6	69·4	22·7	68·8	5·2	106·8	254·3
KII (R11) C1 x Ec. 573 (R12) C1	64·5	97·5	61·8	9·7	81·5	3·8	104·1	235·3
KII (R11) C2 x Ec. 573 (R12) C2	69·0	98·0	56·4	12·4	81·2	5·3	104·6	246·4
KII (R11) C2 Ec. 573 (E2) C4	60·3	98·1	61·9	21·2	76·1	5·6	106·1	247·0
KII (E1) C4 x Ec. 573 (R12) C2	63·8	99·0	64·6	19·1	79·8	6·3	105·6	250·2
KII (E1) C4 x Ec. 573 (E2) C4	60·5	98·1	67·3	20·9	77·6	6·1	106·7	255·1
KIII x Ec. 573 (R12) C2	69·2	99·3	56·9	21·2	77·7	5·4	105·6	245·3
KIII x Ec. 573 (E2) C4	61·3	98·7	67·3	22·3	74·3	5·1	106·7	257·4
SR. 52 x Ec. 573 (R12) C2	71·0	97·6	68·1	13·6	83·3	4·7	100·3	228·8
SR. 52 x Ec. 573 (E2) C4	60·6	98·3	73·9	19·1	77·2	4·6	100·5	220·5
(FxG) x Ec. 573 CO	54·9	98·0	77·5	26·2	72·9	8·3	104·9	241·2
(FxG) x Ec. 573 (R12) C2	68·2	98·0	71·8	25·2	85·4	6·1	102·6	237·6
(FxG) x Ec. 573 (E2) C4	58·2	98·5	72·7	32·6	73·7	10·1	104·0	245·5
KCE x KII CO	49·2	97·8	73·0	19·7	68·3	8·7	106·2	245·0
KCE x KII CO	48·7	98·7	69·7	18·6	68·3	7·9	106·6	244·8
KCE x KII (R11) C2	52·8	99·2	73·9	15·2	72·3	7·1	106·1	237·1
KCE x KII (E1) C4..	49·4	98·0	71·0	19·3	68·5	9·5	107·7	251·1
KCE x Ec. 573 CO	46·0	98·7	67·7	31·7	58·6	5·1	109·5	263·9
KCE x Ec. 573 CO	46·5	97·5	67·8	34·5	62·3	5·0	109·3	267·1

material to warrant such an extensive test. This scheme of alternate year trials may prove reasonable as most of the recurrent selection schemes being utilized require two years per cycle. The principal exception is full-sib selection in the southern Hemisphere where one cycle of testing and recombination is obtained per year. After a one-year interval, renewed interest was shown for the 1970-71 EAMVT. Participation in 1970-1971 has more than doubled over the previous three trials with respect to site. The ten countries growing the trial represents an increase of three over the past two EAMVTs.

The fifteen entries in the current EAMVT include five of the commercial hybrids from Kenya, Ukiriguru and Ilonga composites and their crosses Kawanda Composite A from Uganda and single entries of S.U.28 from Malawi and SR.52 from Zambia.

TABLE BMS/4—YIELDS (q/ha) OBTAINED IN THE 1968–69 EASTERN AFRICAN VARIETY TRIAL GROWN AT 7 LOCATIONS IN KENYA. (NUMBER OF LOCATIONS FOR EACH ALTITUDE ARE IN PARENTHESES. TO CONVERT q/ha TO bu/a, MULTIPLY BY 1·6)

Variety	Below 1,830m (3)	Above 1,830m (4)
H 632	47·4	84·7
H 613B	37·9	93·9
H 511	35·5	45·2
SR.52	38·1	69·0
H 611(R) C1	54·2	104·9
UCB–W x UCA	38·9	73·0
KCB x KCC	43·3	83·1
SR.52 x 63J96	37·7	61·8
SR.52 x 63J347	47·5	68·6
ZCA x UCA	45·2	62·1
ZCA x KCC	36·9	71·0
ZCA x 1C	42·2	48·7
KCB x UCA	39·6	78·1
KCB x 1C	42·7	69·1
KCB x KCE	45·5	88·2
Kawanda Comp. A	40·7	72·6
Zambia Comp. A(ZCA)	38·3	50·0
Ukiriguru Comp. B–Wh. (UCB–W) ..	38·6	62·7
Kitale Comp. B(KCB)	37·9	68·2
Kitale Comp. C(KCC)	44·0	77·2
Kitale Comp. E(KCE)	38·4	75·9
Ilonga Comp. (IC)	40·3	40·7
Ukiriguru Comp. A(UCA)	48·9	75·2
Local Synthetic Var.	41·0	69·7
Local Farmer's Maize	32·0	69·8
Mean	41·3	70·5

SECTION II: APPLIED MAIZE BREEDING RESEARCH—F. OGADA, N. NYAMU, G. RAVAGNAN, E. OMOLO, S. K. NJUGUNA, B. GICHUHI, J. WAKHUNGU, D. MUTHOKA AND E. MWENDA

(a) Late Maturity Maize—Kitale

(i) *Classical breeding*

The maintenance and the usual small scale bulking of the inbreds, A,F,G and D. continued in 1970. In addition to these, the Zambian inbreds N and S were also maintained. The other Kenya lines including K 58, K 56 series and EAAFRO/540747 were also maintained in 1970.

As was reported last year, an attempt to make all possible single crosses of the 17 Kenya lines was only partially successful due to poor seed set in some of the lines that were very late planted. Instead of the 136 possible single crosses only 64 single crosses were evaluated in 1970 at 2 locations. The Kitale location suffered much damage from a storm during the season so that the chances of getting any useful information was again seriously reduced. It was not therefore possible to make a fair assessment on either specific or general combining ability of any of these lines. However, from the little information obtained in this trial and an earlier trial in 1965, three double crosses will be made in 1971 for inclusion in the Late Maturity Maize Variety Trials, L.M.V.T., of 1972. It was also decided to make a partial diallel of these lines for a further final single cross evaluation in 1972.

As a matter of policy, future lines will be developed only from the two composites, KCE and KCB, currently undergoing intensive recurrent selection by S_1 testing and also from Kitale II(R11) and Ec.573 (R12). It is hoped that as the composites or the varieties are improved from one cycle to the next that the top selected lines from each of these sources, advanced to S_3, could be usefully evaluated in single crosses with lines from the genetically divergent source.

During the nursery stages when the lines are advanced to S_2 and S_3 before crossing there will be opportunity for agronomic selection.

In 1970 the scheme of extracting these medium generation lines for evaluation was started in Kitale 11 (R)C2 and Ec.573(R)C2. In January ten best lines from Kitale II(R)C2 and another ten selected lines from Ec.573(R)C2 were each planted in 5 two-row plots with 15 plants per plot. Selected plants were selfed. At harvest only the three best ears were saved from each of the 5 plots grown for each variety, that is 15 ears for each. During the following August only 10 ears from the 15 saved for each variety were shelled and planted in paired rows of 20 plants such that each of the ten of Ec. 573(R)C2 lines were paired with each ten lines out of Kitale II(R)C2 for crossing. At flowering some of the plants in each pair of rows were used for making the hundred single crosses and the others were further selfed to S4. Scoring for *Diplodia spp.* Stalk rot was done as the stalks had been jabbed on the second internode with contaminated nail after flowering.

The 100 single crosses will be in trial at 4 locations in 1971. The lines will also be further selfed to S5.

A similar scheme of extracting was used in KCB(S) and KCE(S) in 1970. The selected lines out of each composites were advanced to S3 by selfing in readiness for making the single crosses in 1971 for evaluation in 1972. The future extraction of lines will be on the completion of 3rd and 6th cycles respectively.

(ii) *Composite Population Improvement*

(a) Recurrent selection in KCE and KCB by S1 testing

The recombination of selected KCE lines was completed during the first irrigation nursery season (January to July) 1969, thus the formation of KCE(S)C1 was completed. During the second irrigation nursery season (August to January) 847 S1 lines were made and these were in trial in 1970 regular season (April to December) at the same time the remnant seed was planted for increase and selfing to S2.

In 1970 the 30 selected KCB lines were recombined during the first irrigation nursery and this marked the completion of KCB(S)C1. During the following irrigation season 360 recombined full-sibs were selfed and these S1 lines will be in trial in 1971, and at the same time the remnant seed of these was planted for increase by selfing to S2.

The number of sets in yield trials has now been reduced from 7 to 3 in order to cope with the increased pressure from other work in the programme. An outline of

FIG. AB/1—OUTLINE OF KCB AND KCE S1 TESTING PROGRAMME

Composite KCB

YEAR	SEASONS		
	April–Dec. Normal season	*January Nursery*	*August Nursery*
1967	Back crossing (KCB x Ec.573) to KCB to increase genetic variability.		
1968		Recombine selected lines KCB(S) CO.	Make 847 S1.
1969	Yield Trial and further increase of 363 to S2.		
1970		Recombine 30 selected lines, complete C1.	Make 360 S1.
1971	Yield trial and further increase of 360 to S2.		
1972		Recombine 28 selected lines complete C2.	Make 363 S1.
1974		Recombine 28 selected lines, complete C3.	
		Composite KCE	
1967	Recombine by full-sib to make KCE(S)CO.		
1968	Yield trial and further increase to S2.		
1969		Recombine selected line KCE(S) C1.	Make 847 S1 lines.
1970	Yield trial and further increase to S2.		
1971		Recombine 28 selected lines KCE(S) C2.	Make 363 S1 lines.
1972	Yield trial and further increase to S2.		
1973		Recombine 28 selected lines KCE(S) C3.	Make 363 S1 lines.

KCB and KCE S1 testing programme is given in Fig. AB/1.

(b) Full-sib selection for prolificacy in the KCB and KCE

(i) *Formation of the first full-sibs*

This work started during the regular season in 1969 with the starting points KCB(F)Co and KCE(F)Co being the same as the starting points of KCB(S)Co and KCE(S)Co respectively. For each population, 4,000 plants were grown in spaced hills 75 cm. x 75 cm. to allow them to express as much of the prolific tendency as possible. At flowering time the selected 1,200 plants were tagged and paired for reciprocal crossing (sibbing) of both ears if possible. Pollination was attempted in 600 pairs of plants in each population. It was noted at this stage that there was still quite a lot of variability within each population as far as flowering dates was concerned and there was a noticeable range of as much as 90 to 115 days.

At the end 1969 season, at harvest, 100 best full-sibs out of each population, KCB and KCE were saved for the first trials of the full-sibs in 1970. The basis for selection of the 100 full-sibs was prolificacy of the parents of each cross and the total grain weight of the crossed seed from both reciprocally crossed plants. Tables AB/1 and AB/2 show the 100 selected full-sibs out of KCB and KCE respectively. As indicated by either (2-prolific) or (1-one eared) in column P in the two tables, only 27 per cent of the selected KCB full-sibs had either one or both parents set seed on both ears. On the other hand 65 per cent of the selected KCE full-sibs had one or both of the parents setting seed on two or more ears.

(ii) *Yield trials of the first full-sibs*

The 100 selected full-sibs from 1969 were grown in yield trials during the main season in 1970. For each of the two composites the 100 entries were grown in 10 x 10 simple lattice with 2 replications grown at 2 locations at N.A.R.S. Kitale—Main station and Top-station. Each composite was grown at 3 population levels as follows:—

53,333	plants/ha.	or 21,578	plants/acre
40,040	„	or 16,200	„
26,666	„	or 10,789	„

The above plant populations were achieved by spacing at 75 m. x 25 cm.; 75 cm. x 33.3 cm.; and 75 cm. x 50 cm. respectively. The first stage selection was done after flowering and when the ears were fully formed and multiple-eared plants could be determined with ease. At this stage 15 entries showing the highest frequency of prolificacy were selected and their remnant seed planted in the August/September irrigation for recombination. The first stage or preharvest selection was based on the mean performance over all plant population levels.

The second stage, post-harvest, selection which was based on grain yield helped reduce the numbers selected from 15 to only 10. (10 per cent selection pressure). The combined data on grain yield and other characters for the 10 selected full-sib lines are presented in tables AB/5 and AB/6 for KCE and KCB respectively.

Although for the purposes of statistical analyses the 3 population levels will be treated as separate experiments, the final selection based on grain yield will take into account yield of the entries at all population levels.

Tables AB/3 and AB/4 give the list of the 15 entries selected in the first stage for KCB and KCE respectively. From these tables it is evident that KCE displays a much higher level of prolificacy than KCB. As expected the rate of prolificacy was influenced by spacing. However, it is also interesting to note that most of the top 10 per cent could have been picked out at any of the population levels at which the trials were grown.

(iii) *Recombination of selected full-sibs*

The remnant seed of the 15 selected full-sibs out of KCB and KCE was planted in the August/September irrigation nursery 1970. For each composite 105 paired rows were planted for making all possible crosses of the 15 which were thus recombined by full-sib. At harvest only the 45 all possible crosses of the 10 full-sib lines selected on

TABLE AB/1—EXPERIMENT 954—K.C.B. SELECTED FULL-SIBS

Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P
1	2–14/1–6	482·1	1	35	13–23/13–4	614·6	1	70	25–6–/26–16	514·6	1
2	1–11/1–8	641·7	1	36	14–2–/14–7	498·1	1	71	16–10/26–6	630·5	1
3	2–7/1–7	526·0	1	37	14–6/13–17	470·4	1	72	25–3–/26–4	619·2	1
4	1–10/1–13	566·4	1	38	13–21/13–25	522·0	1	73	28–22–/27–21	576·9	1
5	1–5/1–3	636·1	1	39	15–15/16–11	570·4	1	74	27–2/27–5	618·0	1
6	1–2/2–9	580·8	1	40	15–19/16–9	576·6	1	75	27–17/28–4	605·6	1
7	1–9/2–5	630·0	1	41	15–20/15–21	551·7	2	76	29–30/30–29	641·5	1
8	1–27/2–25	455·0	1	42	15–25/15–24	607·6	2	77	29–4/30–4	494·6	1
9	3–2/4–8	571·5	2	43	16–29/17–30	466·0	2	78	29–20/30–7	546·7	1
10	3–29/4–21	623·8	1	44	15–29/16–18	464·9	2	79	32–3/31–1	544·4	1
11	4–6–/3–22	572·5	1	45	17–21/18–27	529·3	1	80	32–23/32–22	619·2	2
12	3–8–/4–23	656·9	1	46	17–26/18–25	573·6	1	81	32–24/31–13	608·0	2
13	3–23/3–24	634·2	2	47	18–22/17–28	676·9	1	82	32–29/31–11	640·3	1
14	4–15/3–25	600·2	1	48	18–18/17–17	448·1	1	83	32–17/32–20	539·1	1
15	4–16/3–26	688·3	1	50	18–12/17–9	522·0	1	84	34–21/32–16	497·6	1
16	3–21/4–20	547·4	1	51	19–33/18–3	548·2	2	85	34–30/33–2	461·5	2
17	5–12/6–26	581·7	1	52	19–20/20–24	547·7	1	86	34–28/33–31	552·9	1
18	5–7/6–3	639·1	1	53	19–21/20–14	557·8	1	87	35–9/36–18	557·4	1
19	5–29/6–30	570·6	1	54	20–2/19–28	466·1	2	88	36–29/36–14	704·9	2
20	6–11–/5–11	597·0	1	55	20–5/20–7	586·9	1	89	36–25/35–15	660·1	1
21	7–11/8–13	548·8	2	56	20–6–/20–15	584·9	2	90	37–27/37–29	624·6	1
22	8–21/7–24	629·2	1	57	20–19/19–8	454·9	2	91	38–20/38–8	614·5	2
23	8–28/7–30	660·2	1	58	19–3/19–10	534·5	1	92	37–25/37–20	556·3	1
24	8–30/8–27	564·8	1	59	21–17/22–30	616·6	2	93	37–4/38–14	543·9	1
25	9–30/9–22	515·0	1	60	21–24/22–24	716·3	2	94	34–5/31–6	601·2	2

TABLE AB/1—EXPERIMENT 954—K.C.B. SELECTED FULL-SIBS—(*Contd.*)

Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P
26	10–17/10–21	678·6	2	61	22–26/22–24	535·3	1	95	40–1/39–9	570·8	2
27	10–10/10–12	625·7	2	62	21–4/22–5	669·5	1	96	40–22/40–3	475·2	2
28	10–1/9–1	645·0	1	63	22–29/21–26	654·5	1	97	40–28/39–16	588·2	2
29	11–10/11–8	504·7	1	64	23–23/24–8	607·3	1	98	39–12/40–8	577·8	1
30	11–29/12–30	540·2	1	65	23–24/24–27	572·5	1	99	39–24/39–25	615·7	1
31	12–5/12–3	664·8	2	66	24–22/23–28	544·9	2	100	39–23/39–19	598·1	1
32	12–22/11–22	564·0	1	67	24–18/23–10	575·8	1				
33	11–7/11–5	700·7	2	68	24–5/23–4	645·2	1				
34	11–28/11–19	634·8	1	69	25–5/26–17	548·0	1				

TABLE AB/2—EXPERIMENT 956 K.C.E. SELECTED FULL-SIBS.

Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P
1	1–22/2–14	416·5	2	35	15–12/14–13	508·0	1	69	27–3/27–7	477·4	1
2	1–25/2–27	319·8	2	36	15–19/15–28	346·6	1	70	27–14/27–29	365·2	1
3	2–23/1–18	279·5	2	37	16–15/16–2	427·7	1	71	30–21/30–22	609·5	1
4	2–28/1–19	388·4	2	38	17–15/18–21	494·4	1	72	29–3/30–20	329·5	2
5	13–30/14–19	548·8	2	39	17–17/17–21	516·9	2	73	30–15/30–27	402·2	2
6	14–18/14–25	380·0	2	40	17–6/18–2	435·1	2	74	30–23/29–8	602·5	2
7	14–9/14–4	596·4	2	41	18–6/18–10	354·4	2	75	30–16/29–9	453·0	2
8	13–4/13–8	442·4	2	42	18–24/17–5	627·5	2	76	29–11/29–30	531·7	2
9	4–16/4–29	538·4	2	43	18–28/17–14	372·5	2	77	31–17/31–7	345·7	2
10	4–18/4–9	408·9	2	44	19–6/18–10	624·7	2	78	31–3/31–6	418·1	2
11	3–26/3–27	332·2	2	45	19–24/20–23	530·5	2	79	31–23/31–4	527·6	1
12	4–6/1–17	311·6	2	46	19–27/20–16	458·4	2	80	32–15/32–4	320·6	2
13	4–14/5–20	453·3	2	47	21–2/22–4	560·7	1	81	34–14/34–28	469·9	2
14	4–19/4–20	338·1	1	48	21–5/22–6	486·7	2	82	34–29/33–29	544·5	1
15	6–4/6–8	494·5	1	49	22–28/22–30	378·8	1	83	33–25/33–27	465·5	1
16	6–19/5–15	415·0	2	50	21–29/21–30	334·5	2	84	33–18/34–8	435·6	2
17	5–10/5–12	356·2	2	51	21–20/21–22	450·0	1	85	33–11/33–12	273·4	2
18	6–16/5–17	522·6	2	52	24–6/24–15	503·1	1	86	33–3/36–5	438·7	2
19	7–22/7–27	338·6	2	53	24–18/23–3	406·3	1	87	36–27/35–22	336·0	2
20	7–29/7–30	560·3	2	54	23–7/23–6	323·1	2	88	35–6/35–4	435·4	1
21	8–16/8–21	362·6	1	55	14–1/23–4	408·5	1	89	35/16–35–20	491·1	1
22	10–16/10–30	505·8	1	56	24–23/23–14	483·9	2	90	36–17/36–24	349·6	1
23	9–1/9–12	640·4	2	57	24–22/24–26	651·0	2	91	37–5/38–3	430·7	2
24	9–13/10–20	593·1	1	58	25–20/25–23	436·5	2	92	37–19/38–5	412·0	2
25	10–27/9–30	635·9	2	59	26–28/26–22	326·5	2	93	38–13/38–28	301·9	2

TABLE AB/2—EXPERIMENT 954—K.C.B. SELECTED FULL-SIBS—(*Contd.*)

Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P	Entry Code No.	Pedigree	Grain Wt. (g.)	P
26	10–13/9–6	587·0	1	60	25–19/25–27	512·8	2	94	38–7/38–8	557·4	2
27	10–5/11–29	347·3	2	61	26–15/26–21	545·1	1	95	37–25/37–26	434·2	1
28	11–1/11–25	323·8	2	62	26–18/20–10	520·5	1	96	39–8/40–17	598·2	2
29	11–8/12–4	439·2	2	63	25–25/26–27	523·5	1	97	39–11/39–22	488·0	1
30	12–20/12–17	393·5	2	64	27–23/28–2	524·7	2	98	39–16/39–1	410·0	1
31	12–26/11–21	524·5	2	65	28–13/28–18	310·0	2	99	40–2/40–15	484·3	2
32	12–11/12–13	525·2	1	66	27–6/28–6	679·9	2	100	40–11/39–27	430·1	1
33	12–23/12–24	569·8	1	67	28–10/28–13	679·2	2				
34	15–25/16–23	359·8	2	68	27–21/27–28	575·2	1				

the basis of grain yield were saved. Two best reciprocal crosses were selected from each of the 45 and another one cross from 10 pairs to give a total of 100 full-sib crosses for trial of KCB(F)C1 and KCE(F)C1 respectively. The C1 will be in trial in 1971.

TABLE AB/3—EXPT. 054–KCB. THE 15 SELECTED FULL-SIBS FOR RECOMBINATION AUGUST/SEPTEMBER 1970.

Selection No.	1970 Entry code	Per cent Prolificacy
1	96	34·5
2	59	26·1
3	70	23·5
4	86	22·7
5	17	21·8
6	39	21·6
7	60	20·7
8	8	20·5
9	26	20·2
10	30	19·5
11	66	19·2
12	71	18·6
13	15	18·1
14	44	17·5
15	42	17·4

Mean of selected—21·5
Mean Prolificacy of the population—10·8

Prolificacy at Population — 53,333 plants/ha = 9·1%
Prolificacy at Population — 40,040 plants/ha = 8·5%
26,666 plants/ha = 14·8%

TABLE AB/4—EXPT. 056–KCE. THE 15 SELECTED FULL-SIBS—FOR RECOMBINATION IN AUGUST/SEPTEMBER 1970

Selection No.	1970 Entry code	Per cent Prolificacy
1	43	57·0
2	19	51·4
3	91	46·6
4	9	45·8
5	30	44·2
6	28	43·9
7	12	39·8
8	64	39·7
9	6	37·5
10	85	37·1
11	65	36·6
12	39	33·6
13	5	32·8
14	42	32·2
15	99	31·6

Mean of selected—40·6%
Mean Prolificacy of the Population—21·4%

Prolificacy at Population — 53,333 plants/ha = 15·3%
Prolificacy at Population — 40,040 plants/ha = 17·8%
Prolificacy at Population — 26,666 plants/ha = 29·7%

TABLE AB/5—COMBINED DATA ON THE 10 SELECTED KCE FULL-SIB LINES (EXPERIMENT 056)

Rank	Code No.	Yield q./ha.	Per cent Stand	Per cent Prol.	Per cent Barren	EWNI	Per cent Ears on Stand	Yield/ Plant gms.	No. grain/ plot x 100	No. grain/ Plant	Wt. 1,000 grains	Per cent Lodg.	B. Tip	U. Ear	D. Ear	D.T.	E.H.T.
1	64	86·9	93·3	39·6	0·8	119·8	126·9	245·7	112·0	600·0	448·7	44·6	13·9	126·9	0·8	110·7	105·8
2	65	83·4	100·0	43·8	3·3	131·3	136·0	136·0	114·3	572·0	407·3	45·3	4·8	134·4	1·7	109·7	116·0
3	30	82·8	91·7	44·9	0·0	114·7	123·3	228·0	105·0	573·0	429·0	28·4	36·5	120·8	2·5	99·7	114·0
4	42	80·3	98·3	31·9	5·0	120·2	119·2	212·3	110·7	563·0	393·3	58·7	22·1	119·2	0·0	108·3	117·7
5	19	76·0	88·3	51·2	3·1	120·7	137·4	229·3	96·0	543·0	434·0	49·2	27·7	134·5	2·9	111·5	123·2
6	99	75·6	97·5	31·2	2·8	115·3	119·4	201·0	108·7	553·0	417·7	29·1	9·0	117·8	1·7	107·7	117·0
7	6	73·8	100·0	37·5	5·0	116·0	114·2	186·7	103·7	519·0	375·3	65·0	10·8	112·5	1·7	104·5	104·2
8	43	71·4	98·3	58·0	2·5	117·0	120·2	182·3	102·0	519·0	375·0	74·9	13·8	116·1	4·2	110·3	116·8
9	28	71·4	93·3	44·3	7·1	121·2	121·9	193·0	116·0	622·0	345·0	51·8	17·7	119·4	2·5	114·0	134·2
10	39	71·3	100·0	32·7	9·6	109·0	100·0	197·7	90·7	453·0	451·0	67·3	6·7	100·0	0·0	110·7	112·0
Mean of sel.		77·3	96·1	41·5	3·9	118·5	121·9	210·1	105·9	551·7	407·6	51·4	16·3	120·2	1·8	108·7	116·1
Gen. $\bar{X}$ ..		67·9	96·8	21·56	5·13	109·15	101·2	182·5	90·4	469·0	422·2	54·1	20·7	98·9	2·4	107·4	112·0
L.S.D. ..		12·6	6·00	12·65	6·31	9·96	18·6	33·9	21·83	—	53·8	19·98	11·64	19·39	4·3	2·6	10·2

TABLE AB/6—COMBINED DATA ON THE 10 SELECTED KCB FULL-SIB LINES (EXPERIMENT 054)

Rank	Code No.	Yield q./ha.	Per cent Stand	Per cent Prol.	Per cent Barren	EWNI	Per cent Ears on Stand	Yield/ Plant gms.	No. grain/ plot x 100	No. grain/ Plant	Wt. 1,000 grains	Per cent Lodg.	B. Tip	U. Ear	D. Ear	D.T.	E.H.T.
1	86	84·4	99·2	23·5	0·9	113·3	117·8	224·7	98·5	496·0	450·5	26·4	15·9	112·7	5·0	107·0	93·8
2	70	78·2	99·2	23·6	6·7	116·7	116·7	213·7	89·3	458·0	473·3	30·9	5·9	113·3	3·3	109·2	95·0
3	42	75·6	95·8	17·4	5·3	112·2	113·6	205·8	87·5	457·0	449·5	34·4	2·7	111·9	1·7	110·0	109·7
4	96	70·4	96·7	34·3	4·4	111·2	123·2	188·8	89·3	462·0	412·3	55·3	3·0	120·6	2·6	106·8	97·2
5	8	68·8	96·7	21·0	4·2	115·3	112·0	187·0	78·2	404·0	463·2	36·4	7·6	111·2	0·9	102·3	85·7
6	66	66·0	100·0	19·2	2·5	107·8	100·0	172·5	102·8	520·0	352·2	74·2	17·3	98·3	1·7	105·7	95·0
7	15	66·0	96·7	18·2	5·3	105·7	97·3	182·3	89·3	461·0	395·3	45·7	27·8	93·9	3·4	108·7	97·5
8	30	65·9	98·3	19·5	1·7	111·5	107·6	176·3	79·8	410·0	437·3	50·2	2·3	106·0	1·7	107·8	98·8
9	17	65·4	99·2	21·9	4·2	114·2	104·3	176·0	77·0	388·0	455·0	48·7	5·8	100·1	4·2	111·8	109·8
10	60	62·3	96·7	21·3	21·7	116·2	99·0	172·7	72·3	374·0	462·2	72·8	24·8	98·2	1·8	106·2	92·7
Mean of sel.		70·3	97·9	22·00	5·7	112·4	109·2	190·00	86·4	443·0	435·1	47·5	11·3	106·6	2·6	107·6	97·5
Gen. Mean		65·4	97·08	11·4	5·3	106·5	96·8	178·9	78·4	404·0	442·1	50·2	13·8	93·8	3·6	106·2	99·8
L.S.D. ..		17·6	5·0	9·6	12·5	7·1	15·5	39·8	16·1	—	47·9	23·9	19·12	20·5	5·6	3·4	32·7

TABLE AB/7—LATE MAIZE VARIETY TRIAL—WESTERN AND NYANZA PROVINCE AND EMBU AREA—1970

	Kakamega	Kisii	Maruo	Kaimosi	Busia	Chwele	Homa Bay	Bondo	Dyani	Sangalo	Miwani	Mean (11 loc.)	Embu	Wambugu	Waruhiu	Mean (3 loc.)
	03	11	42	43	45	47	48	49	50	52	53		19	20	61	
1. Kit. II	40·3	38·4	54·4	50·4	31·2	47·5	60·8	28·9	39·6	29·7	52·3	43·1	17·7	22·3	19·2	19·7
2. H 622	66·3	74·9	67·3	57·0	44·0	37·5	89·1	47·6	65·7	45·4	75·3	60·0	24·0	29·0	20·7	24·6
3. H 632	64·8	53·8	73·2	52·8	34·6	63·4	87·4	48·2	53·8	41·3	63·5	57·9	16·2	28·2	21·1	21·8
4. H 613B	52·2	53·8	65·3	54·3	36·0	55·4	74·8	30·4	67·2	41·7	45·6	52·4	26·7	32·0	24·3	27·7
5. H 611B	51·7	44·2	73·3	47·4	34·0	56·7	50·4	44·6	54·9	53·2	33·4	49·4	29·7	27·2	24·2	27·0
6. H 611C	67·3	53·8	60·3	63·0	40·5	65·6	58·1	51·9	70·3	40·5	52·7	56·7	28·1	38·0	28·4	31·5
7. H 511	54·1	31·9	51·8	50·6	32·2	24·4	74·6	48·4	64·5	44·1	60·7	48·8	24·8	28·5	22·3	25·2
8. H 512	74·1	28·8	71·5	60·5	44·2	37·1	80·8	45·1	66·4	50·7	53·1	55·7	21·6	30·6	21·6	24·6
9. SR 52	72·4	26·1	71·0	64·4	48·4	39·0	89·1	57·2	75·3	50·1	52·9	58·7	29·8	22·9	21·8	24·8
10. H613 (R) C2	74·7	74·9	64·0	81·4	41·4	62·2	83·4	45·8	61·4	56·0	47·9	63·0	40·9	39·7	28·4	36·3
11. SR 52 x Ec. 573 (R) C2 ..	75·3	67·2	62·6	61·3	46·8	59·3	88·5	45·2	72·2	59·8	67·8	64·2	36·1	34·7	32·9	34·6
12. H 611 (R) C2	51·6	71·0	49·5	54·5	41·6	77·2	73·1	38·0	61·4	64·8	53·4	57·8	29·4	36·1	25·4	30·3
Mean	62·05	51·55	63·68	58·14	39·59	52·10	75·84	44·28	62·72	48·13	54·06	55·65	27·08	30·76	24·20	27·35
C of V	26·91	23·40	33·98	29·84	17·81	31·16	20·01	23·62	22·16	16·33	23·49		25·41	10·95	24·20	27·35
L.S.D. 05	27·27	19·70	32·68	28·33	11·51	26·51	24·77	17·08	22·70	12·83	20·74	8·39	11·24	5·50	6·57	

TABLE AB/8—LATE MAIZE VARIETY TRIAL—KITALE AND NAKURU AREA—1970

	Top Station 01	Endebess Strong 02	Njoro 04	N.A.R.S. 05	F. 66 06	Chorlim 07	Eldoret 08	Tulienge 09	Russell 10	H. Bell Farm 13	Soy 16	Hoey's Bridge 24	Moiben 26	Lanet (BRS) 28	Njoro (U.N.D.P.) 29	Kaptagett 36	Bavation 44	Average
1. KS II	26·2	39·6	67·2	40·5	50·0	58·7	55·2	30·5	36·0	15·0	13·5	20·4	46·1	45·9	58·1	30·8	13·8	38·1
2. H 622	14·0	58·8	83·2	56·5	66·5	58·8	58·8	32·2	33·4	34·7	22·2	26·5	48·4	44·7	67·0	42·3	26·1	45·5
3. H 632B	23·5	50·3	81·8	40·3	48·1	47·0	55·6	23·2	34·8	25·5	16·2	21·8	44·8	38·9	02·1	46·3	16·1	39·8
4. H 613B	47·9	63·0	101·3	63·4	53·4	101·9	62·1	61·6	67·3	58·0	21·6	34·8	57·1	50·6	64·7	52·8	59·3	60·0
5. H 611B	39·9	61·9	80·7	66·7	65·7	78·7	59·7	57·7	59·0	53·4	26·6	35·7	65·2	33·3	61·3	42·0	43·1	54·8
6. H 611C	38·3	65·5	104·5	86·9	63·9	104·2	67·5	50·3	72·9	63·6	30·0	37·4	60·4	60·2	74·3	63·2	48·8	64·3
7. H 511	39·9	57·9	63·8	53·2	56·0	67·0	52·0	41·1	34·4	37·5	21·2	22·3	59·4	57·5	60·9	35·1	27·3	46·3
8. H 512	63·4	66·7	63·6	68·3	64·5	71·1	48·9	51·4	41·1	47·0	20·1	24·5	53·0	49·1	63·3	40·1	20·2	50·4
9. SR 52	51·1	60·6	59·7	60·9	55·2	59·0	54·5	38·8	53·7	10·4	17·7	24·9	28·2	33·8	54·0	38·9	31·1	43·1
10. 613 (R12) C2	39·5	69·0	100·3	75·9	67·3	106·0	82·3	84·1	80·0	75·3	37·2	35·7	86·0	55·0	76·4	63·4	42·1	69·1
11. SR. 52 x 573 C2	54·2	86·5	104·6	88·7	76·9	98·1	74·9	87·5	98·3	67·8	36·8	42·9	75·0	61·2	80·1	62·2	57·4	73·7
12. H 611 RC2	50·1	79·3	101·9	98·3	73·3	98·0	71·1	83·4	74·8	70·7	38·4	36·6	71·9	43·8	70·8	51·0	52·6	68·6
Mean	40·67	63·28	84·37	66·62	61·73	79·03	61·88	53·50	57·14	46·58	25·09	30·29	57·97	47·83	66·16	47·35	36·51	54·47
C of V	34·75	17·92	14·86	22·39	17·69	13·40	17·95	23·92	21·22	38·53	18·19	15·38	17·97	43·21	13·25	23·20	30·01	
L.S.D. 05	23·08	18·52	20·47	24·36	17·69	17·30	18·13	20·89	19·80	29·31	7·45	07·61	17·01	33·75	12·26	17·94	17·89	

Table AB/9—Late Maturity Maize Variety Trial—1970

Entry	Kitale and Nakuru (17)	Western and Nyanza (11)	Embu (3)	Mean (31)	Stand per cent (31)	Lodging per cent (31)	Bare Tips per cent (31)	Usable Ears per cent (31)	Diseased Ears per cent (31)	Days to Tassel (7)	Ear Ht. (14)
No. of Sites—											
1. KIT II	38·1	43·1	19·7	33·63	96·4	41·4	12·5	77·6	7·0	91·6	212·7
2. H. 622	45·3	60·0	24·6	43·36	97·7	49·8	11·2	88·4	11·0	91·6	190·6
3. H. 632	49·8	57·9	21·8	39·83	97·8	53·1	14·4	81·8	15·5	89·5	187·3
4. H. 613B	60·0	52·4	27·7	46·70	97·2	45·3	23·7	84·1	6·5	89·3	226·4
5. H. 611B	54·8	49·4	27·0	43·73	96·5	40·7	20·8	83·0	8·2	92·6	233·9
6. H. 611C KIII x Ec. 573	64·3	56·7	31·0	50·83	97·4	35·5	18·3	87·3	4·6	91·6	239·1
7. H. 511	46·3	48·8	25·2	40·10	97·2	45·6	23·5	86·8	9·2	79·3	163·3
8. H. 512	50·4	55·7	24·6	43·57	97·1	39·5	18·0	84·4	7·8	81·2	165·2
9. SR. 52	43·1	58·7	24·8	42·20	96·0	34·4	14·7	84·3	5·9	81·4	169·3
10. H. 613C	69·1	63·0	36·3	56·13	97·8	40·2	25·3	94·5	5·4	89·9	220·9
11. SR. 52 x Ec. 573 RC2	73·7	64·2	34·6	57·50	98·4	35·6	15·6	94·9	4·7	85·4	212·1
12. H. 611C (R) C2	68·6	57·8	30·3	52·23	97·3	35·6	14·3	90·5	4·4	91·6	228·0
Mean	54·47	55·65	27·35	45·82	97·2	41·38	16·9	86·5	7·5	87·39	204·1
L.S.D. 05	6·37	8·39	5·35								

(c) Mass selection in KCF, KCE and High Altitude Composite

(i) *KCF.*—This composite has now completed 6 generations of mixing and mass selection (25 per cent). The 81 components are still kept separately although they have largely lost their identity. There are still yellows in this composite but it shows promise and it tends to be earlier than either KCE or KCB by about 2 weeks. It is hoped that this composite will serve as a back-up composite to the intensely selected KCB. However, the future of this composite remains flexible until it is properly evaluated in composite by composite crosses. The evaluation will be done in 1972 following the crosses to be made in 1971.

(ii) *KCE.*—A section of this composite has continued to be maintained by 25 per cent mass selection while the other is being rapidly improved by S1 testing and full-sib methods of recurrent selection. This population serves as a back-up to the KCE(F) and KCE(S). As has been indicated in the past, even the mild mass selection in this composite gives some yield improvement in this material. The progress made by this mild selection will be checked in the composite evaluation trial planned for 1972.

(iii) *High Altitude Composite*

A fourth generation of mixing and mild mass selection was completed in 1970. The composite which now has 30 components will continue mixing for a fifth generation at high altitude location near Kitale before a more intensive selection can be started at Gituamba and/or Ol Joro Orok station when staff and funds permit. However, a preliminary start with 10 per cent mass selection will be made at Ol Joro Orok station following a year of successful bulking and good performance there in 1970. The selection planned for 1971 will be in a population grown from only the pure white kernels out of the 1970 crop.

(iii) *Late Maturity Maize Variety Trials (LMVT)*

The late maturity variety trial was grown at 40 sites in 1970. Yield results were obtained from 31 locations. The data from these trials are presented in tables AB/7, AB/8 and AB/9. The data show that the improved versions of 611 and 613 have again outyielded the original versions in these trials. Both Kitale II(R)C2 and Ec.573(R)C2, improved versions, show superiority not only in grain yield but also the other agronomic characters. One of the most interesting results out of these trials is the performance of the cross SR.52 x Ec.573(R)C2. This cross has outyielded every entry in these trials in all the 31 locations. This cross was also included in a different series of trials in 1970, and in this it also came top overall in 9 locations.

The results from these trials have served to confirm that the use of improved parents, Ec.573(R)C2 and Kit.II(R)C2, in the production of the improved 611 and 613 is a change that must now be implemented without any delay so that the farmers may benefit from the improvement.

With regards to the new cross SR52 x Ec.573(R)C2 the problem that immediately arises is one of practical seed production. The two parents differ widely in their flowering dates and synchronization in field scale is therefore likely to be difficult. However the Kenya Seed Company will be doing a pilot production of the hybrid in 1971. In addition to this the possibility of getting around the problem by first crossing the parents of SR.52 separately with Ec.573(R)C2 will be investigated at the station in 1971.

(b) Medium maturity maize—Embu

(i) *Variety Testing and the short term programme*

In the Embu 11 and 12 the selfs which were made in the October rains 1969 were evaluated in the March rains in 1970. As a result of this evaluation of the pure white S1 lines the remnant seed of the pure white S1 lines out of each composite was planted in isolation to reconstitute the colour free versions. Unfortunately the October rains failed and nothing was harvested at Ndomba F.T.C. where the two populations were grown in isolation. Because of this lost season this step will be repeated in March 1971 from remnant seed.

TABLE AB/10—MEDIUM MATURITY MAIZE VARIETY TRIALS—MARCH 1970
(6 locations in Central Kenya)

Entry No.	Variety	Yield (q./ha.)	Stand Count	Lodged Plants	Bare Tips	Usable Ears	Diseased Ears	Days to Tassel	Ear Height	Per cent to Muratha
1	H. 632	34·7	98·0	46·9	1·4	91·3	14·5	66·1	182·5	121·5
2	H. 512	42·1	97·2	42·9	18·7	82·5	5·2	58·1	171·7	147·4
3	H. 511	33·7	96·2	42·5	21·3	80·1	6·3	55·4	146·7	118·0
4	E. 1 C4 x E. 11 C4 ..	40·4	96·7	35·6	5·6	95·1	7·8	59·9	177·7	141·4
5	E. 1 C5	34·9	97·0	35·9	14·1	83·6	6·9	60·8	188·6	122·2
6	E. 11 C5	37·5	97·7	31·9	10·8	80·4	4·9	59·1	173·6	131·2
7	E1 C3 x SR. 52	37·6	96·2	41·9	10·9	93·3	7·4	63·8	197·7	131·6
8	E11 C3 x SR. 52	38·4	93·7	37·7	14·5	80·2	6·3	58·3	156·2	134·4
9	H. 512	46·0	98·0	33·0	13·2	89·8	6·1	58·6	166·3	161·0
10	Yellow Maize	32·9	97·8	39·8	15·3	81·7	8·7	64·6	198·7	115·2
11	Kat. Comp. A	25·1	97·9	50·9	6·5	72·9	11·3	47·1	97·5	87·8
12	Muratha	28·2	95·7	31·4	5·9	66·5	7·3	56·7	153·0	100·0
	Mean	36·0	96·8	39·2	12·7	83·1	7·7	59·0	167·5	
	L.S.D.	10·9	5·6	17·0	10·5	15·9	8·4	5·8	21·8	

From the March 1970 season harvest a bulk of S1 lines, pollinated with bulk pollen, was made up and sent to the Kenya Seed Company for further bulking and use in seed production. Meanwhile the results of the Medium Maturity Maize Variety Trials, Table AB/10, help confirm the decision to continue the two composites with 5 per cent intensity mass selection as preference should now clearly be given to intensive recurrent selection in the composites I and II which show greater yield improvement potential for the future. The Medium Maturity Maize Variety Trials, also confirm that H.512(SR 52 × H 511) is, at least, equal in yield to H 511 and better in number of agronomic characters. The Kenya Seed Company are convinced by these results and will be increasing their production of H 512 from 165 acres in 1970 to 310 acres planned for 1971. The H 511 will continue to be produced and in 1971, 585 acres planned for production. The yield results also show that the crosses of Embu I x II, Embu I x SR.52, Embu II x SR.52 are also promising. The October rains MMMVT were poor but the two locations grown in Meru offer some indication of the relative performance of the 0_2 versions. These results as shown in Table AB/11 are encouraging.

TABLE AB/11—RESULTS OF THE MMMVT AT KAGURU AND KIANJAE LOCATION IN THE MERU AREA—OCTOBER 1970

Varieties	*Yield q/ha*
H 632	13·2
H 512	38·1
H 511	42·4
Muratha	41·4
Kat. Comp. B	60·0
E11 x 12 opaque	41·3
E1 x 2 opaque	44·7
H 512	40·8
E1c4 x SR.52	35·2
E11c4 x SR.52	50·5
L.S.D.	14·5

(ii) *Recurrent selection in Embu I and II*

The long-term breeding programme for the medium maturity programme will now lay emphasis on these two genetically divergent breeding populations. It was decided that before any intensive recurrent selection is initiated that it would be desirable to get rid of the yellow and other colours so that selection work starts from pure white composites.

Selfs were made in the March rains in 1970 and the selected S1 lines were grown for evaluation in the October season but the rains failed and this phase will now be repeated during the March rains in 1971. If all goes well then the recombination of the two composites from the remnant pure white seed would be completed in the October rain 1971. These would then be ready for intensive recurrent selection in 1972.

The current status of the high lysine programme in the medium maturity material is reported in separate section of this report.

(c) Early Maturity Maize—Katumani

(i) *Katumani Composite B*

Kat. Composite B was released again in October 1970 after colour clearance and small scale bulking by the Kenya Seed Company. At the maize improvement seminar held at Machakos F.T.C. in August 1970 discussions regarding farm to farm sales of improved short maturity maize variety revealed, among other things, that the idea had not been carried out very successfully either due to failure of the extension support

or simply due to apathy on the part of the farmers to the idea of non-original seed which implied second grade quality seed. There were also feelings expressed to the effect that the farmers were beginning to wonder why they had to continue with varieties which were not hybrid as grown in other areas of the country. In view of the foregoing it was decided that the idea of farm to farm sales be dropped. The extension staff agreed that as much fresh seed as required for the area be produced and distributed every season. Despite this decision, the fact of the matter is that farmers who cannot afford the fresh seed will continue to obtain advanced generation seed from their neighbours. No one could stop this and no one would object to the idea.

The Kenya Seed Company is ready and willing to produce as much seed as will be required in 1971. The Katumani composite B will therefore continue to be the early maturity recommended for these marginal areas until such time as better material from the long-term programme becomes available. Improvement by mass selection (10 per cent), initiated in March 1970 will be continued for several seasons to come.

(ii) *Intensive recurrent selection: Synthetics 7 and 8*

Breeding and selection work will now centre on these two divergent composites from the two breeding streams. In 1970 the main effort was on getting rid of yellow colour as had been done in the Katumani comp. B. In synthetic 8 mixing continued for a 3rd generation in March 1970 and selfing would have been done in October 1970 but the season was lost due an almost total failure of the short rains. The selfing to clear the colour will now be done in March 1971. In synthetic 7 a number selected S1 lines were evaluated during the March rains in 1970. The remnant seed of the selected white lines would have been recombined in October to reconstitute the Synthetic 7 white population but, again, due to the failure of the rains this would have to be done in March 1971 so that the start of the first cycle of intensive recurrent selection by S1 testing could start in October 1971.

The progress report on the qualitative gene programme in the early maturity is reported in details in a different section of this report.

(d) Incorporation of qualitative genes

Introduction

High lysine project commands top priority in the qualitative genes programme. Countries where maize is used mainly to feed livestock, farmers can afford to add synthetic lysine at moderate extra cost to the ration, however, cheap tryptophan is not yet available. But in a country like Kenya where maize is the staple food crop of millions of people, it is unrealistic for a housewife to go to the shop to buy lysine to add to the cooking pot or place it at the table as is done with the salt shaker. It is therefore proposed to convert or incorporate in all improved maize hybrids and varieties, high lysine. The hybrid has earned a reputation in Kenya so the problem of convincing mothers about the high protein quality hybrid is a small exercise. Mothers will buy the hybrids as usual and at the same time enjoy the benefit of better protein.

Conversions of high lysine were started at Kitale in the Kenya National Programme in 1966 which was later expanded to include early and medium maize programmes. Although in the early stages the work covered the whole of Eastern Africa, its rapid expansion called for more resources than could be made available at Kitale. Consequently only the national programme was continued while those relating to other countries were handed over to their respective stations. At that time the programme of work covered such diverse fields as opaque, floury brachytic, male sterility and dominant blight resistant genes (Ht.).

When it came to concentrating on the national programme emphasis was placed on the first three genes namely opaque-2, floury-2 and brachytic-2 and only maintained the cystoplasmic male sterile and blight resistant genes so that whenever they are needed they will be available for further investigations.

High lysine breeding presents two important challenges to the plant geneticists. One of this is the development of the high protein quality varieties and the second one is to improve yield. Simple conversion of inbred lines to their opaque-2 or floury-2 does not guarantee high yielding hybrids. Opaque-2 and floury-2 endosperm tend to have a lower density than normal endosperm because they lack translucent (high density) material. This lowers the grain weight. Studies at Illinois and Purdue have shown that the yield reductions are a function of the genetic background. So proper complement of modifying genes can substantially increase the size of the grain or the number to compensate for lower density, besides, there is enough hope that a double mutant, that is combining both opaque-2 and floury-2 genes into one variety bring back the normal endosperm.

The method used to convert maize to high lysine is the standard back-crossing technique. The inbred lines as well as the basic breeding populations will be converted using this method.

The two basic breeding populations that are going through conversions are Kitale composite B (KCB) and Kitale composite E (KCE). Converting these populations is a tiresome job because sufficient numbers must be back-crossed to maintain not only the genetic variability but also the gene frequency of the populations. Once done, however, there is no more conversion in future of any lines derived out of these converted populations which will be genetically pure for high lysine. The populations will be heterogeneous enough and will lend themselves to the intensive recurrent selection to improve the population. At this stage the normal counterpart will be selfed and only renewed once in a while in case it is needed for a further back-crossing.

(i) *Incorporation of Opaque-2 and Floury-2 into KCB and KCE*

KCB and KCE have gone through two cycles of conversions to opaque and floury and in 1971 will be random mated before any further improvement by recurrent selection can start. The determinations of the lysine index of the two cycles have been very encouraging.

TABLE AB/12—CHEMICAL RESULTS OF THE CYCLES OF TWO BASIC BREEDING POPULATIONS; KCB AND KCE

Populations	Gene	Protein Percentage 1969	Lysine index	Cycle
			Co–1979	C1–1970
KCB	Normal	9·7	0·17	0·14
	Opaque	11·3	0·27	0·22
	Floury	—	—	0·23
KCE	Normal	10·2	0·19	0·16
	Opaque	10·1	0·29	0·23
	Floury	11·1	0·28	0·26

Lysine index is a relative measure, and can therefore be misleading if taken for granted. One might be tempted to conclude, after looking through Co and comparing with C1, that the lysine indices tend to drop but this is not the case. Each cycle is looked upon as separate experiment and therefore comparison is only valid within the cycle and not between the cycles.

Lysine determinations are made on the bulk of the seed harvested then selected visually. This may not be ideal, but it served the purpose at that stage because what was required was to check whether or not carried the gene along. It would not be useful to proceed without a preliminary check to show that the gene was still being carried along the line. From 1971 on, determinations will be done on line or plot basis with pedigrees well kept so that only the remnant seeds of the top lines will be chemically recombined to reconstitute the next cycle of the population.

It is still hard to say but looking at the figures and recalling what the plants looked like in the field and the harvested seed, the floury materials look more attractive than the opaques.

At the moment all analyses indicate that those that carry the two genes have higher lysine index than their normal counterparts.

(ii) *Incorporating brachytic-2 into KCB and KCE*

(a) KCB

After going through three cycles of KCB naturally had taken in the brachytic-2 gene a lot better. Approximately four hundred rows of KCB brachytic were planted and at pollination only those plants that fit the description of a brachytic plant were selfed. This was purposely done to fix the gene. At harvest the best plants were kept and in August irrigation nursery further selfing was carried out. These lines will be random mated in a half-hectare field isolation. From there this population will be ready for an S1 intensive recurrent selection, to improve the population. Opaque-2 and floury-2 are also being incorporated in this brachytic population of KCB.

(b) KCE

The programme relating to KCE had a poor start when it was found that the seed that had been designated as brachytic turned out to be normal on being planted. Various possibilities have been advanced for this case. First, it may be that the seed material that was handed out for experimentation was heterozygous brachytic-2 and thus segregation occurred; or there might have been some modifier genes which interacted with brachytic locus to bring about the oddities that were noted and a third and non-genetic possibility could be that as a result of loss of experienced junior technical staff, either pollination or harvesting were not carried out properly. Despite this setback efforts were made to select out the recessive segregates and those left were selfed. Unfortunately when the selfed seed was planted out in the August irrigation nursery most of the populations turned out to be normal. Following this, it was decided to embark on a back-crossing exercise while keeping track of the brachytic gene as the location of this gene would provide an explanation for the oddities that had been noted.

(iii) *Converting the inbred lines*

The present inbred lines A,D,F,G,N and S were initially crossed to the floury-2 in one set of blocks and to the opaque-2 in the other. In August irrigation they were similarly back-crossed to their normal counterparts and the converted inbred lines will be recovered in the main season of 1971.

Converting inbred lines as such presents two problems. It takes a few years to effect conversion and when this has been done, it is not possible to improve the inbred any further. Because of limited financial and personnel resources as are available to the section this work was given a low priority until now. The other problem is that when inbred lines have unfavourable modifier complexes these cannot be changed in lines that are pure genetically. The present efforts assume that such unfavourable modifier complexes are absent. Should such, however be there they will be identified at end of 1971 when the recovered converted inbred lines are planted in the August irrigation nursery. In the absence of the problem, the inbred lines will be crossed to produce single crosses which will eventually give three way or doubles crosses with a view to replacing the present hybrids with those that are high in biological value proteins.

(iv) *Converting varieties*

The parents of the existing varietal hybrids basically Kitale Synthetic 11 and Ecuador 573 were initially crossed to both opaque-2 and floury-2 in separate ranges in the August irrigation nursery. During 1971 main season they will be back-crossed and the recovery of the pure opaque or floury versions of either Kitale Synthetic 11 or Ecuador 573 will be undertaken in the August irrigation nursery.

Kitale 11 and Ecuador 573 recovered will already have high protein quality incorporated in them and being open pollinated, heterogenous population as in the cases of KCB or KCE, improvement will be possible. Lines can be derived out of these for the formation of future high protein quality hybrid. These will also have no complex modifiers as might happen with the inbred line conversions. Whether or not the lysine index will be high shall be confirmed by chemical tests as has been done with the composites.

(v) *Improving protein quality in the medium and early maturity maize*

As the Qualitative Genes programme is based at Kitale, the initial crosses for both Embu and Katumani sub-programmes are carried out at Kitale. The crossed seed is then sent to both places for further back-crosses. This is done to reduce the risk of losing the material and also because the rain season at Kitale is more certain than in the other two places. An example is the failure of the October rains this year.

Floury-2 was introduced into Katumani Synthetic V11 and V111 as well as into the four Embu composites 1, II, 11 and 12 in the course of the year. This is to ensure that in case of double mutant prove to be there the programmes at these two centres will not lag behind the main Kitale work. Table AB/13 is a summary of the chemical analysis of the Embu composites converted to opaque.

Populations	Gene	Lysine index 1970	1969
Embu Comp. I	Normal	0·18	
	Opaque	0·26	
Embu Comp. II	Normal	0·26	
	Opaque	0·29	
Embu Comp. III	Normal	0·14	
	Opaque	0·26	
Embu Comp. 12	Normal	0·14	0·18
	Opaque	0·19	0·27
Embu 1x 11	Normal	0·17	
	Opaque	0·23	
Embu 11 x 12	Normal	0·18	
	Opaque	0·23	

The differences of lysine indices between the normals and the opaques are clearly noticeable. It is encouraging to note that the cross between Embu 11x12, the cross that might replace the H511 behaved as had been expected. Even the cross between Embu 1x11 a wide base, that is eventually supposed to replace the Embu 11x12 did the same.

Embu Comp. 11 normal showed higher lysine index than is expected. This could be attributed to sampling errors, as only a grain of opaque among the normal, if included can produce this kind of result. In future work great care will be exercised to ensure that errors of such a nature do not occur.

As Embu Composite 12 opaque also gave a low value, the same explanation could be advanced, however, there is a need to check also the analytical operations, as the 1969 results were much higher than those of 1970.

The selection of opaque grain is visual, based on the illuminating purity test board. The dull appearance of an opaque or floury grain has been noticed on sulphur deficient grain. There is also xenia effect in the opaque grain, should a normal pollen land on the silk of the opaque plant the harvested grain might have the high lysine index and yet look normal.

(a) Embu Programme—medium maturity

Instead of the usual two seasons, Embu had only one season—the March 1970 long rains. The seed that was sent there after initial crossing was back-crossed in

October 1969/70. Random mating took place during March 1970 to recover the homozygous segregates for chemical analysis and trial, depending on whether enough seed could be obtained. As enough seed was obtained, the first trial including the entries of opaque crosses that were produced during random mating was laid out. However, because of the failure of the October rains, the trial was abandoned and will have to be repeated in March 1971. Although the rains were a total failure, the trial itself was not. With the help of the limited irrigation facilities at the station, it was possible to save the converted materials.

The floury-2 crosses to the composites that had been carried out in 1970, were sent over to Embu for further back-crossing in October, 1970. These could not be saved as they had to be planted in isolation and therefore ended up in a place far from the irrigation dam.

(b) Katumani Programme—early maturity

The initial crosses of Katumani material to opaque were sent to the station for further back-crossing during March 1970 and this was successful. The October 1970 programme failed completely because the seeds that were not irrigated did not germinate. Because of this random mating of materials in isolation to recover the homozygous segregates was not possible. However, recovery will now be done during March 1971 season. The recovered pure opaques will be sent for chemical test as has been done with the material from Embu.

Should there be enough seed, a varietal cross will be made and chemical analysis carried out along with a trial using the normal counterparts as checks. Floury-2 crosses were also sent and due to the crop failure further back-crossing that was supposed to have been done in October 1970 will be done during 1971 long rain season.

Section III—Maize Agronomy Research

(a) Late maturity programme at Kitale—A. Y. Allan, B. S. K. Masyanga and A. Were

Introduction

In 1970, the main features of the Kitale agronomy programme were investigations into the responses of the new hybrids 611C, 613C and 512 to different levels of nitrogen, phosphate and populations; the effects of several different methods of weed control including some new chemical herbicides were studied in another series of trials. and the sulphur investigations started in 1969 were carried on.

Whenever new information of significance and value comes out of the trials programme, it has to be integrated into the current agronomic recommendations, and this function is of great practical importance to the maize-growers in the area around. The maize-growers in the districts near Kitale have the highest average yields in East Africa, with individual grower obtaining yields of over 80 q/ha on commercial fields. These high yields are due to a combination of various factors, of which the agronomy section supplies the specific information on cultural practices, fertilizer and population rates. The farmers in this area also have the benefit of receiving this information very speedily through the local extension team, who work very closely with the agronomy unit.

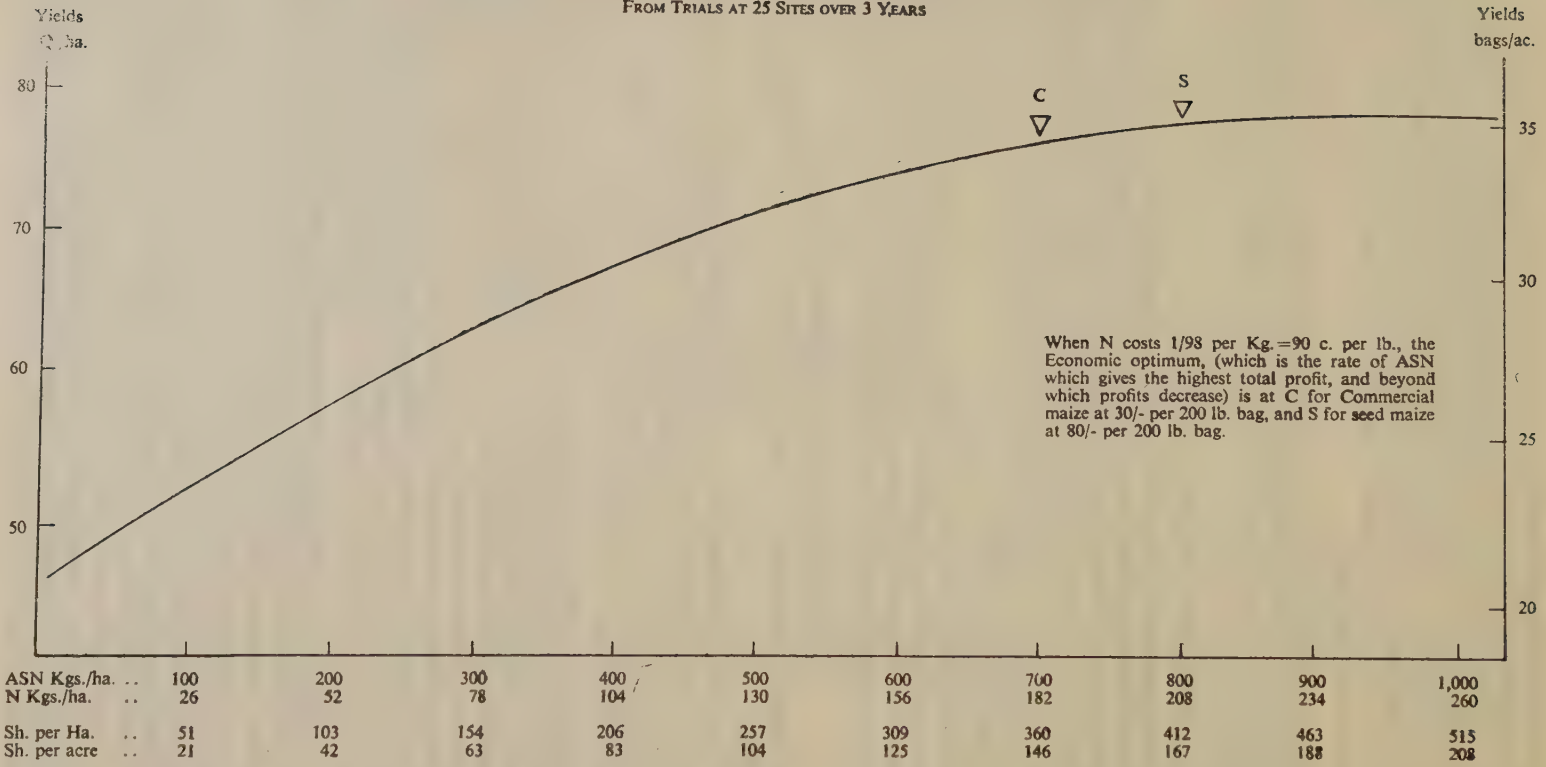
In 1970, plans were drawn up for extending this type of practical agronomy research to the other main maize-growing areas of Kenya, and a formal request for assistance in this Maize Agronomy project was submitted to the U.K. Government.

(i) *Nitrogen, phosphate, spacing trials*

Over 90 separate trials in this series were laid down, 66 of them in the Trans Nzoia district, where the extension team gave very valuable and much appreciated assistance with this work. Most of the trials were on the new hybrids 611C, 613C and 512, with a few on the older hybrids 611B, 613B and 511. Exact comparisons between hybrids are not possible from these particular trials (the exact comparisons are made in the various variety trials reported in the Breeding Section) but there were clear indications that 613C performed best, followed by 611C, with 512 coming closely behind 611C.

Fig. AGR/1—Nitrogen responses on Clay soils, Mt. Elgon and Endebess, 1968-70

FROM TRIALS AT 25 SITES OVER 3 YEARS


Yields
Q./ha.
80
70
60
50
Yields
bags/ac.
35
30
25
20
C
S
When N costs 1/98 per Kg. =90 c. per lb., the Economic optimum, (which is the rate of ASN which gives the highest total profit, and beyond which profits decrease) is at C for Commercial maize at 30/- per 200 lb. bag, and S for seed maize at 80/- per 200 lb. bag.

ASN Kgs./ha. ..	100	200	300	400	500	600	700	800	900	1,000
N Kgs./ha. ..	26	52	78	104	130	156	182	208	234	260
Sh. per Ha. ..	51	103	154	206	257	309	360	412	463	515
Sh. per acre ..	21	42	63	83	104	125	146	167	188	208

The main objects of these trials were firstly to find the responses to N, P and populations, and then to work out the most profitable combinations of these factors for farmers. The design used was a medified factorial (central composite) design, from which a yield equation incorporating the linear, quadratic and linear by linear responses can be derived. The significances of the regression co-efficients in this equation can be tested and then the equation can be used for obtaining the economically optimal rates of fertilizers for different costs of N and P and different maize prices.

In the trials the rate of N ranged from 0 to 1,088 Kg/ha of ASN, the phosphate ranged from 0 to 707 Kg/ha of single supers, and the populations varied from 22 to 66 thousand plants per ha. (9 to 27 thousand per acre). The results from the 2 soil types in the Trans Nzoia district, namely the Mt. Elgon/Endebess clays, and the Kitale red sandy clays, were similar to those in previous years, and it is possible to make fertilizer recommendations based on 3 years' trials results in farmers' field, as shown below:—

(1) On the Endebess/Mt. Elgon heavy clay soils, the main response was again to N, with P responses being low and generally not significant. The N response curve derived from the 25 trials carried out on this soil type over the last 3 years is shown in Fig. AGR/1. From this graph it is possible to read off the fertilizer recommendation directly since it is simply a case of applying as much N as can be afforded, up to a maximum of around 180 Kg/ha of element N. In addition, a small maintenance dressing of phosphate at planting is advisable, and 20-40 Kg/ha of P_2O_5 is recommended depending on the expected yield levels. In these trials, the yield without N was 44.9 Q. and with the optimum rate of 704 Kg ASN/ha it was 75.5 Q. The profitability of using this rate is shown in Table No. AGR/1.

These figures shown in Table No. AGR/1 show that even at these high rates of ASN, the farmer can get Sh. 2/82 back for every 1/- spent on this fertilizer. At lower rates of ASN, the return per shilling is even greater.

TABLE NO. AGR/1—PROFITABILITY OF ECONOMIC OPTIMUM RATE OF ASN ON ENDEBESS/MT. ELGON SOILS, TRANS NZOIA, 1971

	Per Ha.	Per acre
Yield with Economic optimum, 704 Kg/ASN/ha ..	75·467 Q	33·6 bags
Yield without ASN	44·930 Q	20·0 bags
Increased yield due to ASN	30·537 Q	13·6 bags
Value of increase at Sh. 30 per bag	Sh. 1,007.72	Sh. 408.00
Cost of 704 kg. ASN	Sh. 356.85	Sh. 144.50
Profit from ASN	Sh. 650.87	Sh. 263.50
Profit percentage	182%	182%
Value: Cost ratio	1:2·82	1:2·82

(2) On the Kitale red sandy clay soils, which are derived from Basement Complex parent material, there were highly significant responses to both P and N, with positive though not statistically significant interactions between P and N. These results were similar to those in 1968 and 1969, and in view of the fact that in all years there was a positive though non-significant P and N interaction, it was decided to include this term in the regression equations. These equations are shown below, along with the method of using them for working out the fertilizer recommendations for this soil type. In the equations, the adjusted mean yield is the yield obtained at the middle rate of fertilizers and spacing, i.e. 70.7 Kg. P_2O_5 and 141.4 Kg N per ha, and 44,000 plants/ha (18,000 plants/acre). The equations are:—

1968, $Y = 71.266 + 5.526P + 8.980N + 0.232PN - 2.200P^2 - 4.706N^2$ — 18 sites
1969, $Y = 64.332 + 3.919P + 6.227N + 1.171PN - 1.823P^2 - 4.506N^2$ — 17 sites
1970, $Y = 69.030 + 4.647P + 10.495N \times 1.650PN - 3.250P^2 - 5.659N^2$ — 16 sites
Mean, $Y = 68.253 + 4.715P + 8.538N \times 0.990PN - 2.404P^2 - 4.938N^2$ — 51 sites

To obtain the current fertilizer recommendations, the current fertilizer costs and maize prices are required.

Price of Maize, January 1971, is 30/- per 200 lb.=33/- per Quintal (100 Kg.)

Cost of fertilizers, January 1971, is Single Supers 14/35 per 50 kg.=1/44 per Kg. P_2O_5= 65c/lb.

ASN 25/70 per 50 Kg.=1/98 per Kg.N=90c/lb.

In the above yield equations, one unit of N was 100 Kg./ha. of N, which would cost 198/-. —one unit of P was 50 Kg./ha. of P_2O_5, which would cost 72/-.

To obtain the economic optimum rates of N and P, the yield equation is differentiated for N and P separately, and the 2 simultaneous equations thus produced are solved:—

$$\text{(i) } \frac{\text{Cost of 100 Kg N (1 unit of N)}}{\text{Price of 1 Quintal maize}} = \frac{198}{33} = 6{\cdot}0 = \frac{DN}{DM} \text{ (yield equation)}$$

$$= 8{\cdot}538 + 0{\cdot}990P - 9{\cdot}876N$$

$$\text{(ii) } \frac{\text{Cost of 50 Kg } P_2O_5 \text{ (1 unit)}}{\text{Price of 1 Quintal maize}} = \frac{72}{33} = 2{\cdot}182 = \frac{DP}{DM} \text{ (yield equation)}$$

$$= 4{\cdot}715 + 0{\cdot}990N - 4{\cdot}808P.$$

Simplifying (i) $9{\cdot}876N = 0{\cdot}990P + 2{\cdot}538$; (ii) $0{\cdot}990N = 4{\cdot}808P - 2{\cdot}533$

Solving (i) and (ii) N = 0·316 = 31·6 + 141·4 = 173·0 Kg N/ha = 665 Kg/ha of ASN

P = 0·592 = 29·6 + 70·7 = 100·3 Kg P_2O_5/ha = 501·5 Kg/ha of S.S.

To obtain the equation specifying the optimum combinations of N and P_2O_5

$$\text{(iii)} \quad \frac{6{\cdot}000}{2{\cdot}182} = \frac{8{\cdot}538 + 0{\cdot}990P - 9{\cdot}876N}{4{\cdot}715 + 0{\cdot}990N - 4{\cdot}808P}$$

Simplifying, (iii) P=0·887+0·312 or N=1·127P−0·352.

∴Where P=0·592 then N=0·316 i.e. the Economic Optimum.

Where N= −1·414 then P= −00·942=24 Kg./ha. P_2O_5.

In terms of S. Supers and ASN, this equation (iii) means that:—

(i) 120 Kg/ha of S. Supers should be applied before it becomes necessary to use any ASN.

(ii) For every 100 Kg/ha of S. Supers in excess of 120 Kg/ha, it is necessary to top-dress with 175 Kg/ha of ASN.

For example; With 220 Kg/ha of S. Supers, the ASN should be 175 Kg/ha
With 400 Kg/ha of S. Supers, the ASN should be 490 Kg/ha
With 500 Kg/ha of S. Supers, the ASN should be 665 Kg/ha

Fig. AGR/2 shows the relationships in equation (iii) graphically, and the fertilizer recommendations can be obtained easily from this graph. From the overall yield equation given above, the yield without any fertilizer was 36.8 Q3ha, while the economic optimum rates of 500 Kg Single Supers and 665 Kg ASN per ha increased yields to 72.7 Q/ha. The profitability of using these rates is shown in Table No. AGR/2.

Fig. AGR/2—

Fertilizer Recommendations for Sandy Clay Soils. Trans Nzoia at January 1971 costs and prices

BASED ON 51 TRIALS IN 1968, 1969 AND 1970

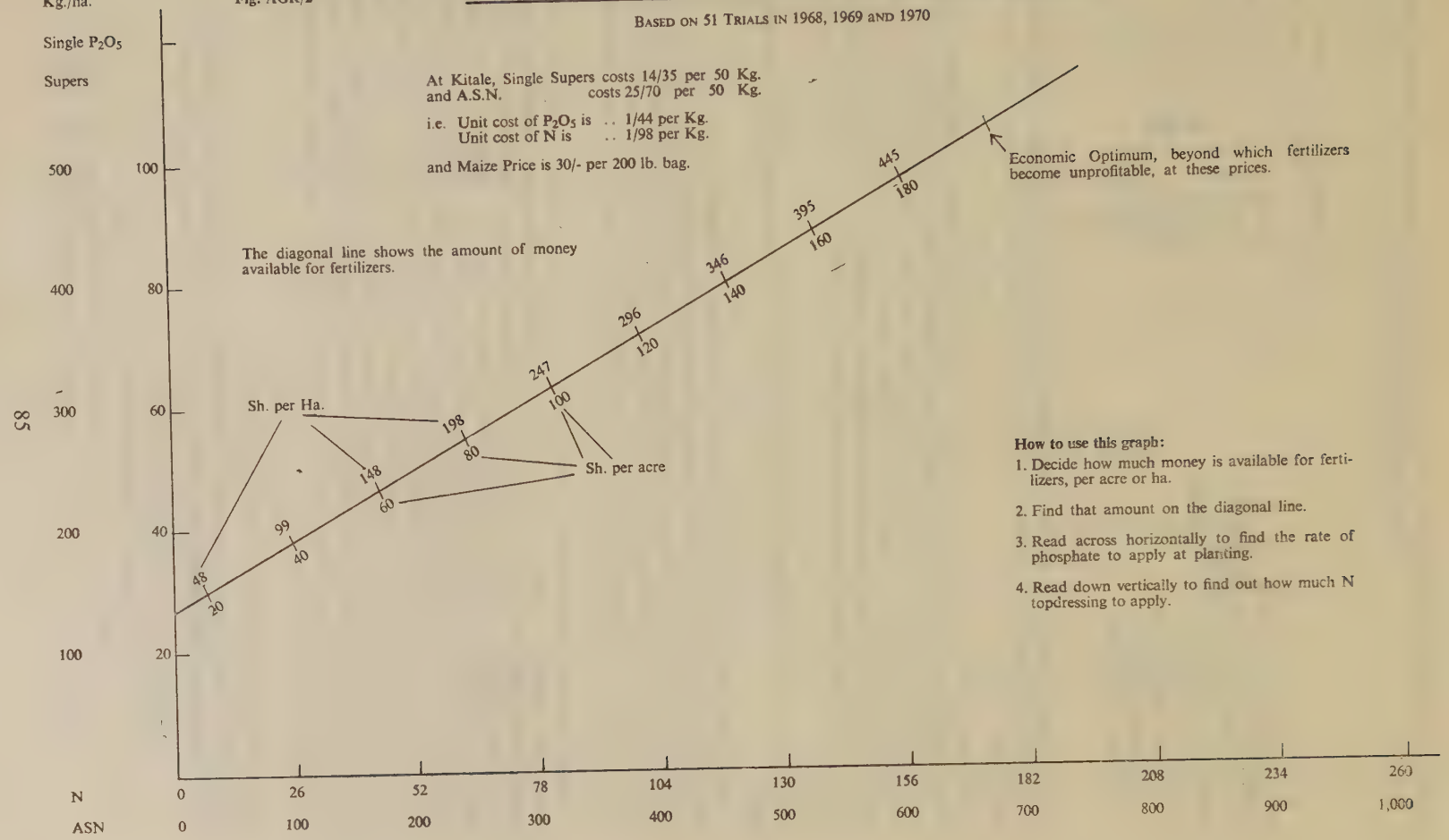


TABLE NO. AGR/2—PROFITABILITY OF ECONOMIC OPTIMUM FERTILIZER RATES OF SANDY CLAYS SOILS, TRANS NZOIA, 1970

	Per hectare	Per acre
Yield without any fertilizer	36·798 Q	16·4 bags
Yield with 500 Kg SS + 665 Kg ASN	72·592 Q	32·4 bags
Increase yield due to fertilizer	35·794 Q	16·0 bags
Value of increased yield at Sh. 33 per Q	Sh. 1,181.20	Sh. 480.0
Cost of fertilizers	Sh. 485.60	Sh. 196.60
Profit from fertilizers	Sh. 695.60	Sh. 283.40
Percentage profit	143%	143%
Value: Cost Ratio	1:2·43	1:2·43

These figures show that at these high rates of fertilizers, it is possible to get a return of Sh. 2/43 for each Sh. 1 spent. At lower rates of fertilizer, the return per Sh. 1 is even higher.

The responses to populations are shown in Fig. AGR/3 for the Trans Nzoia trials. It was found that 611C and 613C gave their optimum yields at populations of 40-42 thousand plants/ha (16-17 thousand/acre); in previous years hybrids of this type have given their best yields at around 45-50 thousand plants/ha (18-20 thousand/acre). It is thought that the optimum populations in 1970 were somewhat lower because of several severe windstorms in July which lodged the higher populations at some locations very badly.

Hybrid 512 gave its highest yields at stands of 45-50 thousand/ha (18-20 thousand/acre).

These trials were also laid down in some other parts of Western Kenya, but not in sufficiently large numbers to enable sound recommendations to be based on them yet. It is hoped that once the expanded maize agronomy project gets under way, it will be possible to carry out sufficient trials in these areas, so that they will have fertilizer recommendations for maize which are as reliable as the Trans Nzoia ones described above.

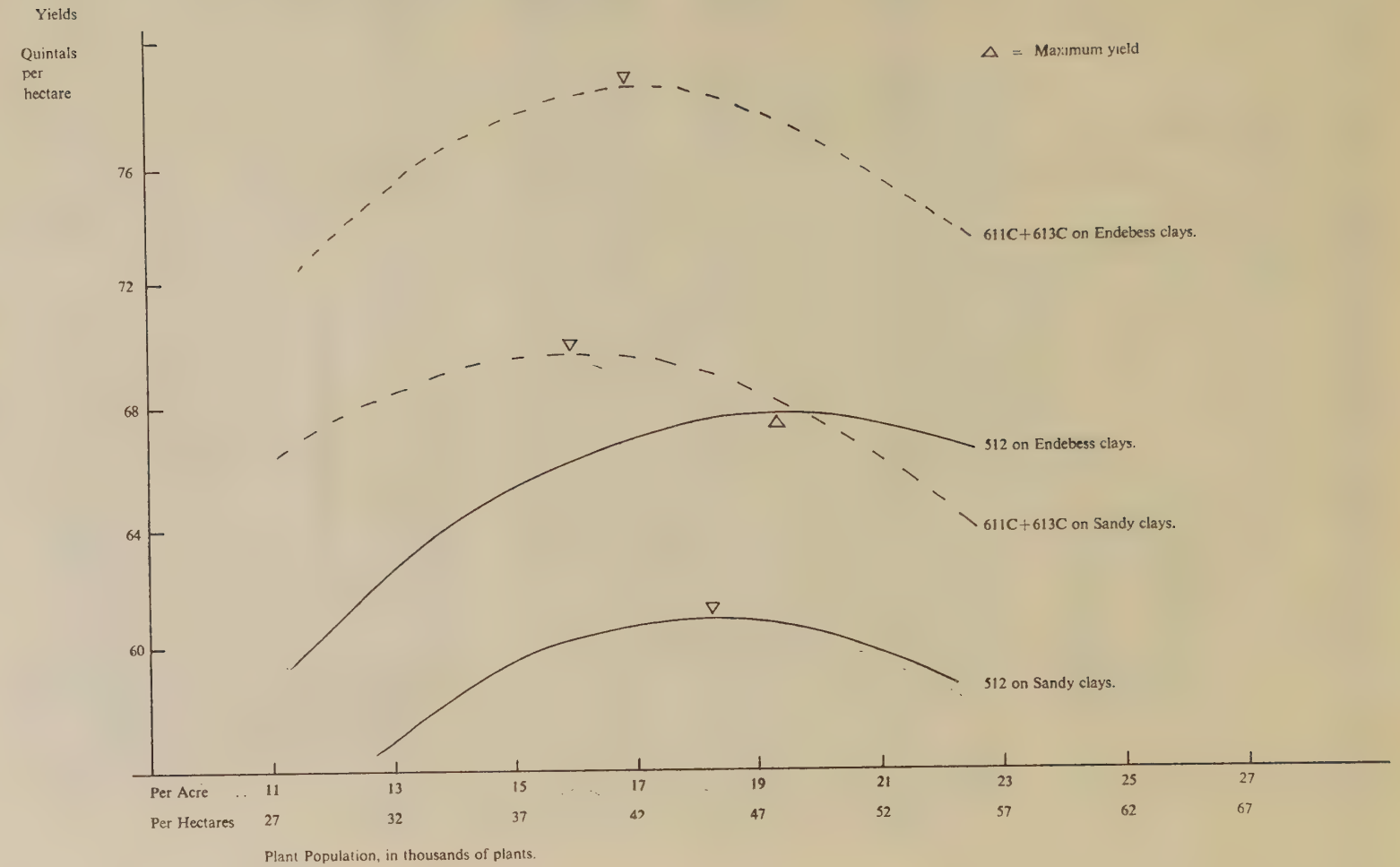
It may be noted however that in 1970 the trials in Soy district gave rather low yields, due to dry weather at critical stages, and the phosphate responses in these trials were lower than in previous years. In one trial on Eldoret Research Station (now Eldoret Large-scale Farmers' Training Centre) the average yield of 97.4 Q/ha was obtained, which is almost twice as high as previous average maize yields in trials there, and must be the highest maize yields ever recorded on that soil type. There were high N and P responses in this trial, and it appeared that when the rainfall there is above average, as it was in 1970, the potential for maize is much higher than formerly believed. The trials carried out on the UNDP Beef Research Station at Lanet and Njoro indicated that grain yields of over 80 Q/ha could be obtained with hybrids 611C and 613B. There were no significant fertilizer responses there, but the higher populations gave significantly higher yields.

(ii) *Fertilizer trials investigating sulphur (S) responses*

The sulphur trials were a repetition of those done in 1969. There were 11 treatments which were intended to provide the following 4 main comparisons:—

Treatment 1 was control, with no N, P or S
„ 2-5 applied standard N and P, without any S
„ 6-10 „ „ N and P, with 42 Kg S per ha
„ 11 „ „ N and P, with 84 Kg S per ha

Fig. AGR/3 — Effects of Plant Populations on yields—Trans Nzoia 1970



The actual rates and combinations of the fertilizers applied are shown in Table No. AGR/3. In these trials, the fertilizers used and their approximate contents of N, P and S were as shown below:—

Code		%N	% P_2O_5	%S
D.S.	Double superphosphate	—	40	*
S.S.	Single superphosphate	—	20	12
DAP	Diammonium phosphate	18	48	*
U	Urea	46	—	—
CAN	Calcium ammonium nitrate	26	—	—
ASN	Ammonium sulphate nitrate	26	—	12

* = small, negligible amount of S.

The results of these trials are shown in Table No. AGR/4, and these have been condensed in Table No. AGR/5 to show the sulphur effects more closely. The results showed as in 1969 that S had an overall significant effect, that the addition of S did not significantly reduce yields at any individual location, and that at some individual sites such as Shishi farm, it increased yields tremendously. As in the previous year, the effects of S were greatest on land which had just newly been broken from grass, especially where the ploughing had been done late.

Most farmers, and all the extension staff in this district are now "Sulphur-conscious", so that severe deficiencies should not occur, but in other areas of Kenya, it is quite possible that sulphur shortages could become even more serious in future, as farmers improve their yield levels, thereby increasing the demands for S, and as more and more compound fertilizers which contain little or no S are used. Therefore it would appear that this is another problem which the expanded maize agronomy programme should tackle at an early stage.

When Kitale hybrids of the 613 type are sulphur deficient, the grain has a typical dull yellowish-white appearance, in contrast to its normal bright, rather flinty, translucent characteristics. S-deficient grain is also softer and mealier, and more susceptible to weevil attack. The grain appearance of the opaque and floury high-lysine genotypes is rather similar to that of S-deficiency, and this similarity could possibly cause confusion in selection work, if it was carried out under conditions where S-deficiency might occur.

(c) Weed control trials, with some new herbicides

Trials were laid down at 5 sites in the Trans Nzoia District, to compare some new, and old, herbicides with each other and with hand methods. The details of the 25 different treatments are shown below in Table No. AGR/7. The main weed problems at the 5 sites are as follows:—

N.A.R.S. Top Farm Mexican marigold—*Tagetes minuta*
Pigweed—*Amaranthus spp.*
Blackjack—*Bidens pilosa*

Strong, Endebess.—Water grass—*Cyperus rotundus*
Annual setaria—*Setaria verticillata*

Sabwani, Endebess.—Chinese Lantern—*Nicandra physalodes*
Wandering Jew—*Commelina spp.*
Water grass—*cyperus rotundus*
Black Bindweed—*Polygonum convolvulus*

Chorlim, Mt. Elgon.—Chinese Lantern
Wandering Jew

TABLE NO. AGR/4—RATES AND COMBINATIONS OF N, P, AND S PER HECTARE

Treatment Code No.	KGMS. OF PURE NUTRIENT APPLIED PER HA.					KGMS. PER HA. FERTILIZER					
						At Planting			Topdressed		
	Seedbed S	Topdressed S	Total S	P_2O_5	N	D.S.	S.S.	D.A.P.	U	C.A.N.	A.S.N.
01	0	0	0	0·0	0·00	0	0	0	0	0	0
02	0	0	0	70·7	141·4	177	0	0	307	0	0
03	0	0	0	70·7	141·4	177	0	0	0	544	0
04	0	0	0	70·7	141·4	0	0	147	251	0	0
05	0	0	0	70·7	141·4	0	0	147	0	442	0
06	42	0	42	70·7	141·4	0	354	0	307	0	0
07	42	0	42	70·7	141·4	0	354	0	0	544	0
08	0	42	42	70·7	141·4	177	0	0	0	190	354
09	0	42	42	70·7	141·4	0	0	147	0	88	354
10	21	21	42	70·7	141·4	89	177	0	0	367	177
11	42	42	84	70·7	141·4	0	354	0	0	190	354

NOTES.—D.S. = Double superphosphate
S.S. = Single superphosphate
D.A.P. = Diammonium phosphate
U. = Urea

TABLE NO. AGR/5—SULPHUR TRIALS—TRANS NZOIA 1970

YIELDS—Q./Ha. (2·24 Q./Ha. = 1 Bag/Ac.)

All treatments, except control, received 70 kg. P_2O_5 + 141 kg. N per ha. (1·12 kg./ha. = 1 lb/Ac.)
Treatments 6–10 received 42 kg. Sulphur; No. 11 received 84 kg. Sulphur/ha.

Sulphur Treatment	Types of Fertilizer	LOCATIONS									
		Noigam	Hulme	Leys	Davids	Birer	Cox	Soy	Magero	Shishi	Means
1. Control ..	O	32·4	25·9	20·9	29·7	46·7	13·1	10·7	10·8	19·0	23·3
2. No. S	DS+U	72·3	60·3	64·8	61·5	52·6	68·3	20·4	35·5	27·0	51·4
3. „ „	DS+CAN	54·0	42·9	56·3	54·5	61·4	33·0	27·4	31·3	15·9	41·9
4. „ „	DAP+U	58·9	58·7	68·2	51·7	57·6	58·2	26·3	39·0	28·6	49·7
5. „ „	DAP+CAN	57·9	58·1	66·5	62·3	55·6	66·3	22·8	28·9	21·2	48·8
6. S in Seed-bed ..	SS+U	64·4	50·0	52·3	65·4	55·4	59·9	22·7	56·4	76·9	55·9
7. Seed-bed ..	SS+CAN	68·5	55·4	71·8	79·6	61·4	72·4	20·3	54·4	81·9	62·9
8. S Top-	DS+CAN+ASN ..	71·7	54·9	46·3	62·9	58·2	64·7	18·6	40·7	78·6	55·2
9. Dressed	DAP+CAN+ASN ..	74·6	49·2	64·4	79·7	65·3	84·7	28·6	47·5	72·9	63·0
10. S in seed-bed and top-dressed.	DS+SS+CAN+ASN ..	78·1	47·8	56·7	74·6	63·4	63·3	21·6	46·3	80·4	59·1
11. Double S ..	SS+CAN+ASN ..	72·6	55·8	67·7	80·4	59·8	63·0	27·4	43·0	79·4	61·6
Averages ..	.. ..	64·1	50·8	57·8	63·8	58·0	58·8	22·4	39·9	52·9	52·1
L.S.D.—5% ..	.. ..	16·7	11·2	—	14·9	—	—	—	8·5	13·0	10·4
C.V. % ..	.. ..	13·2	11·0	23·0	19·0	20·4	30·1	25·7	10·6	12·2	29·9
F	.. ..	XX	XX	—	XX	—	—	—	XX	XX	XX

TABLE NO. AGR/6—SULPHUR TRIALS—TRANS NZOIA 1970

YIELDS IN QUINTALS/HECTARE

TREATMENT	LOCATIONS									
	Noigam	Hulme	Leys	Davids	Birer	Cox	Soy	Magero	Shishi	Means
1. No Fertilizer	32·4	25·9	20·9	29·7	46·7	13·1	10·7	10·8	19·0	23·3
2. No Sulphur 70 kg. P_2O_5 + 141 kg. N/ha. ..	60·8	55·0	64·5	57·5	56·8	56·5	24·2	33·7	23·2	48·0
3. 42 kg. Sulphur + 70 kg. P_2O_5 + 141 kg. N/ha...	71·5	51·5	58·3	72·4	60·7	69·0	22·4	49·1	78·1	59·2
4. 84 Kg. Sulphur + 70 kg. P_2O_5 + 141 kg. N/ha..	72·6	55·8	67·7	80·4	59·8	63·0	27·4	48·0	79·4	61·6
Significance	XX	XX	—	XX	—	—	—	XX	XX	XX

NOTES.—A. Treatment 1 is averaged over 2 plots at each location
„ 2 „ „ 8 „ „ „
„ 3 „ „ 10 „ „ „
„ 4 „ „ 2 „ „ „
Therefore the comparisons between 2 and 3 are most accurate.

B. The most severe S deficiency symptoms were at Shishi and Magero

TABLE NO. AGR/7—YIELDS FROM WEED CONTROL TRIALS, TRANS NZOIA, 1970—Q/ha
THE CHEMICALS WERE SPRAYED AT RATES SHOWN, IN LITRES (L.) OR KG. PER HECTARE

	NARS	Str.	Sabw.	Chor.	Rusl.	Mean
Control—no weeding	32·1	28·5	55·1	63·8	76·0	51·1
Weeding by jembe 3 times, at 10, 45 and 90 cms.	61·3	64·5	73·1	103·8	67·1	74·0
Weeding by jembe once at 10 cms.	56·7	51·7	76·8	99·9	63·5	69·7
Weeding by jembe once at 90 cms.	31·9	47·3	80·3	74·5	80·6	62·9
1.4 L. 24D Ester pre-emergence	71·6	40·7	77·8	79·8	76·7	69·3
2.1 L. 24D Amine post-emergence	60·1	48·1	81·8	93·2	67·4	70·1
24D. 1.4 L. pre-emergence + 2.1. L. post emergence	62·9	42·6	72·6	99·1	71·3	69·7
Lasso—3 L. pre-emergence	53·1	51·9	81·8	93·8	73·1	70·7
Lasso—4 L. pre-emergence	39·2	33·7	75·7	91·0	60·9	60·1
Sutan 5·6 L. disced in pre-plant	57·6	52·0	71·1	76·1	70·8	65·5
Sutan 8·4 L. disced in pre-plant	68·5	54·1	66·2	82·0	67·6	67·7
Eptam 5·6 L. disced in pre-plant	63·2	55·2	73·7	91·3	76·9	72·1
Eptam 8·4 L. disced in pre-plant	84·1	60·3	71·8	87·6	70·1	74·7
Atrazine 2 Kg. + Butisan 6 L. pre-emergence	58·0	40·4	76·7	97·0	77·6	69·9
Atrazine 2 Kg. + Butisan 8 L. pre-emergence	73·9	59·0	72·4	89·3	69·1	72·7
Atrazine 2 Kg. + Butisan 9 L. pre-emergence	71·8	47·0	84·2	86·9	68·4	71·7
Atrazine 3 Kg. + Butisan 6 L. pre-emergence	88·8	50·3	76·3	96·2	69·4	76·2
Atrazine 3 Kg. + Butisan 8 L. pre-emergence	65·6	58·6	79·2	94·7	76·6	74·9
Atrazine 3 Kg. + Butisan 9 L. pre-emergence	73·7	59·5	74·5	94·8	80·9	76·6
Atrazine 4 Kg. + Butisan 6 L. pre-emergence	47·1	53·1	76·3	106·7	62·3	69·1
Atrazine 4 Kg. + Butisan 8 L. pre-emergence	43·9	43·0	78·6	101·2	72·4	67·8
Atrazine 4 Kg. + Butisan 9 L. pre-emergence	74·0	52·6	75·3	102·0	72·6	75·3
Atrazine 3 Kg. alone pre-emergence	64·8	54·9	78·6	91·5	72·8	72·5
Butisan 9 L. pre-emergence	44·9	52·8	77·5	93·4	53·2	64·4
Atrazine 3 Kg. post-emergence	53·5	52·7	72·1	100·7	70·5	69·9
Average yields	60·1	50·2	75·2	91·6	70·7	69·6
Significance of F-test for treatments	—	X	—	XX	—	XX
Coefficient of variation per cent	25·5	15·7	14·5	9·2	16·8	17·7
Least significant difference, 5 per cent level	—	16·2	—	17·3	—	11·0
Least significant difference, 1 per cent level	—	—	—	23·4	—	14·5

Chorlim, Mt. Elgon.—Mexican marigold
Black bindweed

Russell, Cherangani.—Commelina
Tagetes
Not many weeds on this site.

The effects of the different methods of weed control on yields of grain are shown in Table No. AGR/7. The control yields were quite high, but this was due to the fact that the land had been well prepared in most cases, and this underlines the importance of good land preparation for controlling weeds. Clean weeding by hand increased yields by almost 50 per cent and there were no other methods which were significantly better than this. Some of the herbicidal treatments were just as good, and in the case of such treatments the costs of the herbicides becomes of critical importance *vis-à-vis* the cost of hand or mechanical control. At the moment 2,4-D is the only one which is economically competitive, and others, such as atrazine, which give good results, are too expensive for commercial maize-growing. Eptam showed some promise for the control of water grass, the main problem at Strong, Endebess, but again the cost is considerably more than that of hand-weeding. The new chemical, Butisan, was tried in various combinations with atrazine, but none of the combinations differed significantly from atrazine alone. Atrazine gave good weed control, but is also more expensive than hand-weeding; it would be possible to reduce its cost by applying it as a band spray along the rows, and cultivating between the rows with a tractor-mounted cultivator.

(b) Medium maturity maize programme at Embu—N. Njeru

In the long rains only two experiments were conducted, both of which were being continued from previous years:—

(i) *Nitrogen, Phosphate and Spacing Trials*

This was a continuation of the earlier District Cultural Trials. It had five levels of phosphate, Nitrogen and spacing (or population), viz. 0, 20.7, 70.7, 120.7 and 141.4 Kg P_2O_5/ha; 0,41.4, 141.4, 241.4 and 282.8 Kg N/ha; 60, 40, 30, 24 and 20 cm. within each row. All rows were at 75 cm. spacing, giving plant populations of (in thousands) 22.2, 33.3, 44.4, 55.5 and 66.7 per hectare. The trial was carried out at the Research Station and at Wambugu F.T.C. in Nyeri, with Hybrids 511 and 512 at each site.

At the Research Station there were positive responses to Nitrogen (5 per cent level) and spacing (1 per cent level) with H.512 while H.511 responded only to spacing at 1 per cent level. Nitrogen application, however, was uneconomic.

Though there were no significant responses to either fertilizers or spacing at Wambugu Centre with H.512, H.511 responded significantly to both phosphate (5 per cent level) and spacing (at the 1 per cent level).

TABLE AGR/8—YIELDS OF H.511 (Q/ha) AT THREE P_2O_5 LEVELS AT TWO SITES 1970

Site	P_2O_5 Kg/ha 20·7	70·7	120·7	t values	8 df.
Embu	68·28	65·20	68·12	0·090	N.S.
Wambugu	65·95	72·12	77·08	2·647*	
Means	67·11	68·66	72·60	2·112	N.S.

TABLE AGR/9—YIELDS OF H.512 (Q/ha) AT THREE NITROGEN LEVELS AT TWO SITES 1970

Site	N (Kg/ha) 41·4	141·4	241·4	t values	8 df.
Embu	73·80	77·43	80·04	3·244*	
Wambugu	72·91	76·13	80·53	1·814	N.S.
Means	73·36	76·78	80·28	3·595	**

TABLE AGR/10—YIELDS OF H.512 AT THREE POPULATIONS (Q/ha) 1970

Site Pop. (Thousands)	33·3	44·4	55·5	t values	8 df.
Embu	71·09	77·43	77·56	3·745	**
Wambugu	70·77	76·13	78·00	1·916	N.S.
Means	70·93	76·78	77·78	3·956	**

TABLE AGR/11—YIELDS (Q/ha) OF H.511 AT THREE POPULATIONS, 1970

Site Pop. (Thousands)	33·3	44·4	55·5	t values	8 df.
Embu	61·38	65·20	65·48	2·570	*
Wambugu	64·36	72·12	80·81	4·355	**
Means	62·87	68·66	73·14	4·403	**

Closer spacing of maize significantly increased lodging (0.1 per cent level with H.512 at Embu and Wambugu), while phosphate decreased it at the 5 per cent level. At Wambugu, too, increasing Nitrogen increased the amount of lodging.

Probably because cobs were not too big at high populations, increasing plant population very significantly decreased bare tip percentage.

Usable ears also increased as the population decreased, probably due to less lodging at the low population which thus decreased rotting.

Conclusions

From this year's fertilizer/spacing trial, both phosphate and nitrogen fertilizers did not give good response. Where nitrogen did, it was uneconomic to apply it. Phosphate, however, helped in decreasing lodging in H.512 at Embu.

Population increased yields of maize and decreased the problem of bare tip. It, however, increased lodging and diseased ears.

(ii) *Time of Planting, Spacing Trial*

This experiment was a continuation from previous years and it consisted of four times of planting at weekly intervals from the start of rains.

The interactions between time of planting and plant populations was also investigated.

TABLE NO. AGR/12—YIELDS Q/ha. OF FOUR TIMES OF PLANTING AND FIVE POPULATIONS EMBU 1970

	T1	T2	T3	T4	Means
S_5	67·52	54·02	54·57	52·72	57·21
S_4	76·40	72·15	76·77	67·52	73·21*
S_3	61·60	84·17	73·07	67·71	71·64* S.E.
S_2	74·00	78·62	83·25	75·85	77·93** ± 4·55
S_1	81·40	79·55	68·45	61·97	72·84*
Means	72·18	73·70	71·22	65·15	S.E. ± 2·89
L.S.D.	P =	0·05	0·01		
Time	T =	7·07	N.S.		
Spacing (Population)	S =	9·23	16·49		
T x S ..	=	18·57	N.S.		

There was a definite decrease in yield as planting was delayed after rains started. Planting any time within two weeks after onset of rains did not differ significantly, however. This is perhaps understandable since rains continued until August, giving a total of 583.6 mm. of rain during the whole of the growing season.

Decreasing the spacing within the row (increasing the plant population) increased the yield, although this dropped at the highest population (88,889 plants/ha) due to much rotting as a result of high lodging percentage.

(c) Early Maturity Maize Programme, Katumani—J. B. S. Makatiani

Introduction

Land was prepared early to suitable seedbed for all the trials at Katumani and Kampi Ya Mawe. The layouts were marked accordingly and all trials dry-planted except for time of planting for which late treatments were planted at various times after the onset of rains.

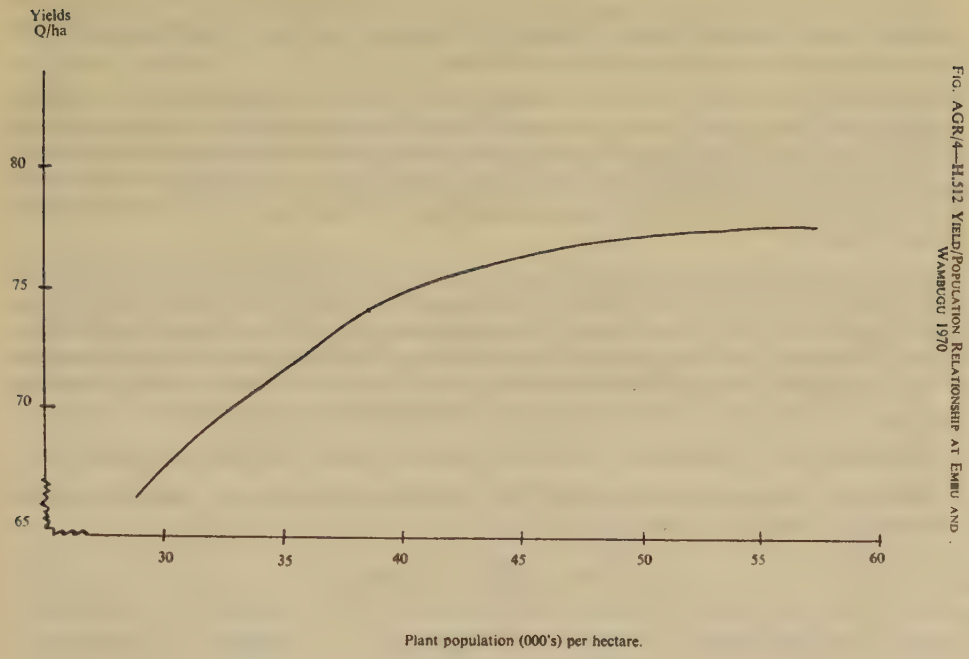
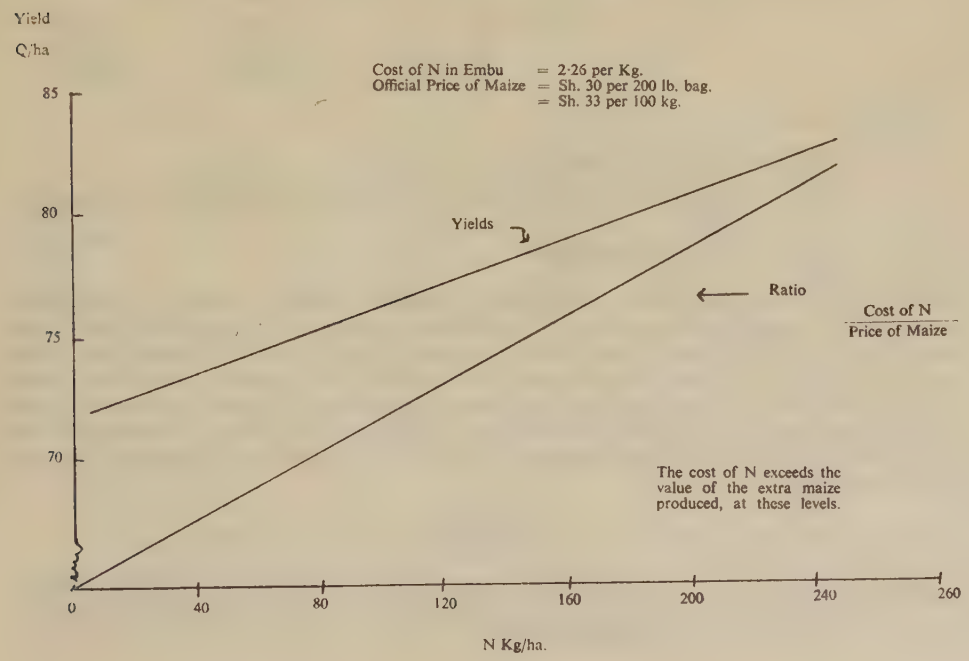


FIG. AGR/4—H.512 YIELD/POPULATION RELATIONSHIP AT EMBU AND WAMBUGU 1970

FIG. AGR/5—EFFECT OF NITROGEN ON H.512 MAIZE AT EMBU AND WAMBUGU FARM, 1970



Marked strings used for spacing, pangas or hoes, tapes and fertilizers were some of the materials used. Fertilizers were a treatment, these were at 0 and 120 Kg/ha for both Double Supers and Ammonium Sulphate Nitrate.

Irrigation treatments were (*a*) natural rainfall and (*b*) supplementary irrigation satisfying the EO balance on weekly basis. That is, Woodhead (1968), irrigation would be done to supply a little more water than the total EO water (Et) lost by crop up to end of that week. This is an extremely rough method but in the absence of better tools to estimate soil moisture and irrigation it sufficed. Whole blocks were either irrigated or not irrigated.

Time of planting treatments were To-dry planting; T_1—Planting 7 days after the onset of rains; T_2—14 days after onset of rains and T_3—21 days after the onset of rains. Seven days after rains the fields were still clean enough to plant without recultivation, but the weeds had already germinated and in the next few days before the germination of the crop, these weeds had become very big. T_2 and T_3 were recultivated before planting since there was a large amount of weeds covering the ground.

Populations were different for maize and beans as shown in Table No AGR/13.

The weed treatments were common to all trials except in the method of weed removal. The weed treatments were:—

TABLE AGR/13—MAIZE

Treatment	Spacing	Plants/acre	Plants/ha.
P0	75×60 cm.	8,997	22,222
P1	75×40 cm.	13,495	33,333
P2	75×30 cm.	17,993	44,444
P3	75×20 cm.	26,990	66,667
Beans			
P0	50×30 cm.	26,990	66,667
P1	50×20 cm.	40,489	100,000
P2	50×15 cm.	53,981	133,333
P3	50×10 cm.	80,972	200,000

W0—Control—no weeding at all.
W1—Clean weed in the first three weeks after crop emergence only.
W2—Clean weed to start at three weeks after emergence and to continue to harvest.
W3—Clean weed throughout.

At harvest whole plants were cut at ground level and weights recorded per harvested area. The cobs here then removed and weighed samples of the stover and cobs were taken for dry matter estimation purposes. These were air dried and where they were oven dried the temperatures and time of drying were equivalent to air drying (90°C for 12 hours), in both cases the samples were further ground and tested for moisture contents using ultra-violet lamp with a scale in order to standardize the dry matter content. Roots were ignored in this study. The ratios of grain to total dry matter was calculated as

$$\frac{100 \times GDM}{TDM}$$

Also samples of weeds were harvested. Five samples were taken systematically from all plots. Weights were recorded per each sample and a composite sample from the bulk was taken for dry matter calculations.

(a) Total Dry Matter (TDM)

The mean total dry matter for long rains was higher than that for short rains. The irrigated treatment in the short rains almost approached that of the long rains. The differences between irrigated and non-irrigated treatments were significant in both seasons but were much more different in the short rains which were very poor in distribution and in total amount. It was quite clear that rainfall was limiting in the short rains. Note that for the purposes of this trial, TDM does include only the crop dry matter and not weeds dry matter (WDM) which is worked out separately.

(b) Grain Dry Matter (GDM)

The mean grain dry matter appear to follow the same trend as that for TDM. However, the differences in this case were not as pronounced, and in fact in 1970 L.R. there was no difference between Irrigation Grain Dry Matter and in the short rains. It appears that the other parts of the plant, that is, other than grain may benefit more from prolonged seasons in which rain exceeds optimum requirements.

(c) Crop Index (C.I.)

An important measure of crop yield is the Crop Index which measures the efficiency of converting assimilates into the economic portions (grains in this case). Many factors appear to affect this measure. Here the supply of moisture is one of these factors. Generally speaking favourable growth conditions will give a better C.I. Under the conditions at Katumani it appears that the crop tends to have a higher crop index under drier conditions, as especially seen from the short rains. This was also evident in the 1970 long rains where the no-irrigation treatment gave poorer results which were slightly better than those of the 1969/70 short rains.

(i) *Irrigation Trials*

The effect of irrigation on maize and weed yield is summarized in Table AGR/14.

TABLE AGR/14—THE EFFECT OF IRRIGATION ON MAIZE YIELD PARAMETERS AND WEEDS. Q/HA EXCEPT FOR C.I. WHICH IS GRAIN AS A % OF TOTAL DRY MATTER

Season	Yield Component	Irrigation		Mean	LSD AL 5 Per cent
		No irrigation	Irrigated		
1969/70 S.R.	TDM	33·05	81·67	57·30	17·12
	GDM	17·16	28·07	22·61	8·76
	C.I.	41·44	26·92	34·17	12·59
	WDM	5·02	10·08	7·55	4·29
1970 L.R.	TDM	83·2	95·2	89·2	6·9
	GDM	34·7	34·7	34·7	—
	C.I.	40·1	38·4	39·2	4·3
	WDM	9·4	11·3	10·4	—

(d) Weeds Dry Matter

In both seasons irrigation increased the weed dry matter yields. Both crops and weeds benefited from extra moisture. It would appear from these data that when irrigation is applied it increases weed growth which eventually is reflected in lower yields of the crop which would have otherwise benefited from irrigation.

TABLE AGR/15—THE EFFECT OF IRRIGATION ON BEAN YIELD PARAMETERS AND WEED DRY MATTER

Season		Irrigation		Mean	LSD 5 Per cent
		No Irrigation	Irrigated		
1970	TDM	44·0	33·4	38·7	7·9
L.R.	GDM	24·5	20·6	22·6	—
	C.I.	56·3	61·0	58·7	—
	WDM	6·3	4·2	5·2	2·4

In this trial it is noted that irrigation had an adverse effect on Total Dry Matter, grain dry matter and weed dry matter. The lower yields in this experiment cannot be adequately accounted for. But perhaps because of the somewhat good rains irrigation created a waterlogged situation and this adversely affected both bean and weed growth. As this was the first irrigation experiment involving beans, and particularly as it was in the long rains, the data are not adequate for generalization.

(ii) *Fertilizer Factors*

TABLE AGR/16—THE EFFECT OF FERTILIZERS ON MAIZE YIELD PARAMETERS AND WEED DRY MATTER (IN Q/HA EXCEPT FOR C.I. WHICH IS A PER CENT)

Season	Yield Component	Fertilizers		Mean	LSD 5 Per cent
		F0	F1		
1969/70	TDM	46·4	68·2	57·3	10·1
S.R.	GDM	17·0	28·3	22·6	8·5
	C.I.	33·3	35·1	34·2	3·6
	WDM	6·1	9·0	7·6	1·6
1970	TDM	56·9	121·6	89·2	10·1
	GDM	22·8	46·5	34·7	4·8
L.R.	C.I.	39·4	39·1	39·2	6·0
	WDM	11·1	9·6	10·4	—

(a) Total Dry Matter (TDM)

Fertilizers appreciably increased the TDM in both the short rains and long rains and more so in the long rains when it exceeded twice the no-fertilizer treatment. Soil moisture was adequate in the long rains. There is no doubt that fertilizers are a major factor limiting yield of maize (Katumani maize). However, further investigations are required, especially at higher fertilizer rates, in those areas growing the Katumani types.

(b) Grain Dry Matter (GDM)

What was said about TDM applies equally well to the grain component of yield. Grain yields were also appreciably increased by fertilizer application.

(c) Crop Index (C.I.)

Fertilizers do not seem to affect the ratio: $\frac{100 \times GDM}{TDM}$ This is rather interesting feature and requires further investigations. It would be valuable to see more of the applied fertilizers end up in more grain and higher proportion of grain to the rest of the Total Dry Matter. The situation might be different at fertilizer rates higher than

used in this trial. The C.I. as presented in the tables were computed on individual plot basis and therefore these tend to differ slightly from what would be obtained by computing the same from the TDM and GDM as presented in these tables.

(d) Weed Dry Matter (WDM)

Weeds were increased in the short rains and decreased in the long rains by fertilizers. Perhaps the increased crop total dry matter in the long rains did have some effect on the weed dry matter. The differences between F_0 and F_1 were not significant for the 1970 long rains.

TABLE AGR/17—THE EFFECT OF FERTILIZER ON BEAN YIELD PARAMETERS AND WEED DRY MATTER IN Q/HA EXCEPT FOR C.I. WHICH IS A PERCENTAGE

Season	Yield Component	Fertilizers		Mean	L.S.D. 5 Per cent
		F0	F1		
1970	TDM	35·8	41·6	38·7	2·5
	GDM	21·7	23·3	22·5	—
	C.I.	60·5	56·8	58·7	0·31
	WDM	5·6	4·9	5·2	—

Fertilizers increased both the total dry matter and the grain dry matter but for the latter the difference was not significant. Fertilizers reduced the crop index significantly but did not affect the weed dry matter. This trial was not carried out during the 1969/70 short rains, and therefore, there are no results for comparison from the previous season. The trial will be repeated in the 1971 long rains.

(iii) *Time of Planting Trials*

TABLE AGR/18—THE EFFECT OF TIME OF PLANTING ON MAIZE YIELD PARAMETERS AND WEED DRY MATTER IN Q/HA EXCEPT FOR THE C.I. WHICH IS A PERCENTAGE

Treat	Katumani 1969/70 S.R.				KAT. 1970 L.R.				KYM. 1969/70 S.R.			
	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM
T0	71·2	19·0	21·6	7·5	99·8	37·4	34·2	10·3	75·2	8·2	9·9	—
T1	58·1	16·5	21·6	8·8	64·2	22·6	28·4	8·2	59·0	7·9	12·9	—
T2	19·2	11·3	54·3	5·4	91·5	36·0	38·6	4·7	25·3	6·2	21·6	—
T3	20·7	4·5	26·0	7·2	70·7	24·9	34·1	4·7	18·8	6·7	28·0	—
Mean	42·3	12·8	31·1	7·2	81·6	30·2	33·8	7·0	44·5	7·2	18·1	—
LSD 5% ..	15·0	6·2	—	2·9	6·5	2·9	4·7	2·6	11·1	2·2	7·5	—

(a) Total Dry Matter (TDM)

Total dry matter decreased with delay in planting. At times this decrease was not evident depending on the rainfall distribution in the given season. Maize planted during a very wet time did not do as well as maize planted at a later time when soil conditions were much more favourable. This is a common observation at Katumani, there are always very heavy storms almost every day immediately the season begins. This may be in the first 14 days after the onset of rains and at this time the soil becomes water-logged and temperatures drop. Work at Kitale has suggested this effect of time of planting in terms of water-logging effect. This would seem to be the case here at Katumani. The pattern established by the TDM was reflected in the GDM yields.

(b) Crop Index (C.I.)

The Crop Index is much higher for maize under some water stress in these experiments. When water is limiting, the crop index drops to zero. However, treatments with high crop index yield poorly per unit area while those with a low crop index yield well in these experiments. Stress may result from unfavourable conditions coming in

before the crop matures for late planting treatments or when there is less water available to the growing plants in a normal season. For example, treatment T_2 which is a late planting, planted after peak rains have passed and has therefore, very short time of growth, the plants will try to hurry up and more of the assimilates are sent to the reproductive parts. Under very extreme conditions plant growth is cut short, probably some essential processes cannot proceed and in this case the C.I. is low and the yield per unit area is also low.

Weed Dry Matter (WDM)

Two seasons compare very well and have practically the same mean. Time of planting effect on weed yield is significant. This is so because in the early planted crop, the control treatment—(no weeding at all) had a large amount of weeds and so was T_1, and all along the line. Planting late disturbed the weeds present. The effect of weeds on crop yields will be discussed later.

TABLE AGR/19—THE EFFECT OF TIME OF PLANTING ON BEAN YIELD PARAMETERS AND WEED DRY MATTER IN Q/HA EXCEPT C.I. AS PERCENTAGE

Treat	Katumani 1969/70 short rains				Katumani 1970 long rains				KYM 1969/70 short rains			
	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM
T0	6·4	2·0	25·4	4·1	55·6	28·8	51·8	5·4	8·7	2·7	27·3	—
T1	5·0	1·7	28·5	3·6	47·7	23·5	44·3	7·8	12·4	3·2	27·0	—
T2	5·2	1·7	30·6	2·8	25·2	11·9	46·4	7·4	6·0	2·0	30·3	—
T3	5·1	0·6	12·4	3·7	37·2	15·6	41·3	4·0	7·8	2·4	25·5	—
Mean	5·4	1·5	24·2	3·6	41·4	19·9	47·0	6·2	8·7	2·6	27·5	—
LSD 5% ..	1·2	0·9	12·9	1·1	9·2	6·5	0·59	—	2·9	0·9	—	—

(a) Total Dry Matter (TDM)

1969/70 short rains were short and erratic and inadequate for maize crop at both Kampi Ya Mawe and Katumani. The mean yields were thus very low. Delay in planting generally decreased yields. Early planting was therefore advantageous. In 1970 long rains at Katumani, the yields were excellent and delay in planting lowered yield even more severely. Grain Dry Matter yields behaved in a similar way as may be seen from the data in Table AGR/19.

(b) Crop Index (C.I.)

In short rains, crop index increased with increasing delay in planting. In the long rains the crop index was highest with early planted crop probably because of the equable growing conditions throughout the season, the plants were fully developed and were able to spare more sink space for available assimilates.

(c) Weeds Dry Matter (WDM)

The early planted treatments had a higher WDM. This has been explained in the above experiments.

(iv) *Population Trials*

TABLE AGR/20A—THE EFFECT OF POPULATION ON MAIZE YIELD PARAMETERS IN Q/ha. EXCEPT FOR C.I. WHICH IS A PERCENTAGE

Treat	Katumani 1969/70 short rains				Katumani 1970 long rains			
	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM
P0	18·8	12·0	—	4·1	84·5	29·8	32·0	11·0
P1	17·7	9·3	—	3·0	84·0	31·5	33·7	10·0
P2	20·3	9·1	—	4·0	96·0	31·3	31·5	9·5
P3	22·5	6·2	—	4·5	86·0	28·2	32·3	6·8
Mean ..	19·8	9·1	—	3·9	88·1	30·2	33·1	9·3
LSD 5% ..	3·8	2·5	—	2·2	—	5·2	—	6·2

TABLE AGR/20B—KAMPI YA MAWE

Treat	1969/70 short rains				1970 long rains			
	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM
P0	57·8	6·2	9·2	—	86·7	28·9	33·4	—
P1	65·7	2·7	3·8	—	91·7	29·1	31·5	—
P2	72·2	1·8	2·1	—	100·1	28·1	27·9	—
P3	69·0	0·9	1·1	—	110·2	20·7	19·0	—
Mean ..	66·2	2·9	4·01	—	97·1	26·7	27·9	—
LSD 5% ..	11·2	1·8	2·0	—	12·0	4·7	5·4	—

(a) Total Dry Matter (TDM)

The mean total dry matter in the short rains of 1969/70 was very low at Katumani and only fair at Kampi Ya Mawe. In the 1970 long rains, however, there was not much difference between the two locations following favourable rainfall at both places. Higher populations had a higher total dry matter produced at both places and in both seasons.

(b) Grain Dry Matter (GDM)

The mean grain yields were very low at Kampi Ya Mawe and a little better at Katumani in the short rains. In the long rains the difference between the two places was small, but the yields were good due to favourable rainfall at both locations. In the short rains, as population increased the yields decreased, but, in the long rains the picture was not this clear although the trend was still evident.

(c) Crop Index (C.I.)

The Crop Index was lowest at KYM in the 1969/70 short rains and highest at Katumani in the same season. In the long rains the difference between the two places was not big. Higher populations gave a lower crop index. This means that as population increases, the plants are able to satisfy only vegetative parts early in the season, but, as the plants become more competitive for growth resources, the increased competition becomes detrimental to grain yields. One can think of competition between plants and that between parts of the plant as two separate competitions coming at different times in the growing season.

(d) Weed Dry Matter (WDM)

It appears that higher populations do reduce the yields of weeds as seen in this study particularly at Katumani in the 1970 long rains. In the short rains this did not occur. It may be possible that higher populations do actually reduce weed crop, that is, immediately after germination weeds are unshaded and are at an advantage because they grow faster and tend to shade crops. However, weeding puts the crop in an advantageous position previously held by weeds and with closer crop population a full canopy is developed early which shades weeds much better. This advantage is probably more when growing conditions are more favourable to the crop. This might have been the case in the long rains of 1970. In the short rains 1969/70 the weeds survived better under the poor crop growing conditions.

TABLE AGR/21—THE EFFECTS OF POPULATION ON BEAN YIELD PARAMETERS AND WEED DRY MATTER

Treat	Katumani 1970 short rains				Katumani 1970 long rains			
	TDM	GDM	C.I.	WDM	TDM	GDM	C.I.	WDM
P0	8·4	4·1	37·2	6·9	29·2	17·6	62·2	8·0
P1	9·2	4·4	40·8	7·2	37·7	23·0	61·9	7·4
P2	10·6	5·1	41·8	7·0	35·4	21·6	61·0	6·9
P3	10·4	5·2	42·2	7·6	39·9	23·5	59·9	7·4
Mean ..	9·4	4·7	40·5	7·2	35·5	21·4	61·2	7·4
LSD 5% ..	2·3	0·9	4·3	—	4·1	3·2	—	—

(a) Total Dry Matter (TDM)

Mean total dry matter was very low in 1969/70 short rains. In the 1970 long rains the yields were three-and-half times that of the short rains. Higher populations had higher dry matter in both seasons.

(b) Grain Dry Matter (GDM)

Mean grain yields in the long rains, were four and half times that for short rains and again yields increased as population increased.

(c) Crop Index (C.I.)

Crop index is very high for beans and the short rains crop index increased as population increased. In long rains 1970 the index was very high but decreased with increasing plant population.

(d) Weed Dry Matter (WDM)

Populations did not have any effect on the amount of weeds. Table AGR/22 below shows the effect of weed removal on the various plant yield characteristics.

(a) Total Dry Matter (TDM)

The mean total dry matter varied for both seasons and locations and the variation was explained in terms of growing conditions mainly the available rainfall. Some generalizations can safely be drawn from these results. Clean weeding throughout gave the best yields. Weeding in the first three weeks was enough to increase yields to near maximum and in most cases this treatment was not very different from the clean weeding throughout the crop season. The economic value of this finding is discussed under grain yields. Clean weeding starting at three weeks after germination of crops was too late as these results show, moreover, it is more expensive in terms of labour requirements. This treatment was invariably inferior to clean weeding in the first three weeks only. Control (no weeding at all) was the poorest treatment and needs no comments. It would appear that, the effect of clean weeding in terms of yield increases to maximum in the first three weeks at both Katumani and Kampi Ya Mawe and then decreases very fast thereafter. Crop loss due to weeds occurs in a very short period after germination and cannot be rectified by late weeding.

(b) Grain Dry Matter (GDM)

The pattern of response to periods of weed removal is very much the same as discussed under TDM. One observation to be made here is that the higher total dry matter constantly appearing at Kampi Ya Mawe is also consistently giving a lower grain dry matter than that at Katumani. This is rather interesting as the reverse should have been the case. While there are no possible explanations for this, there are indications that altitude might be a factor in this.

(c) Crop Index (C.I.)

Crop index depends on GDM and TDM variables. At Kampi Ya Mawe C.I. is consistently lower than that at Katumani. Kampi Ya Mawe is 1,130 m. above sea level while Katumani is about 1,700 m. above sea level. In early growing stages crops and particularly maize are healthier at Kampi Ya Mawe than at Katumani and also they grow faster at the former place. At Katumani maize grows very slowly and therefore nearly resembles the Kitale types which giving lower yields under Katumani conditions. In actual practice this is not the case. Yields are higher at Katumani than at Kampi Ya Mawe.

Table AGR/23 shows the effect of weeds on bean yield data.

(a) Total Dry Matter (TDM)

Essentially what was observed in the case of maize applies to beans. Beans, however, give much lower yields per unit area. There were very slight differences between the W_1—Clean weeding up to three weeks and W_3—Clean weeding throughout. W_1—Clean weeding up to three weeks was the best on all account. W_2—Clean weeding after three weeks was inferior to W_1—Control—no weeding at all was the poorest.

(V) WEED TREATMENTS:— This study examines the effects of time of weed removal on crop yields. The implications of this study are important particularly with reference to (a) general farm planning and management and (b) economics.

TABLE AGR/22—EFFECT OF WEEDS ON MAIZE YIELD PARAMETERS

Trial No.	Name of Trial	Location	Season	W_0			W_1			W_2			W_3			MEAN			LSD at 5%		
				TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.
1	Time of Plant Maize..	K.Y.M.	1969 SR	25·2	2·0	7·3	52·1	10·3	24·4	40·7	7·7	19·5	52·3	9·0	21·2	44·6	7·2	18·1	8·4	2·6	5·1
2	Maize population ..	„	„	51·9	0·5	1·0	75·8	4·5	5·4	64·3	3·4	5·1	72·8	3·2	4·5	66·2	2·9	4·0	11·2	1·8	2·0
3	Maize population ..	„	1970 LR	84·3	19·6	24·2	107·7	29·6	28·0	94·0	29·0	31·2	102·7	28·7	28·4	98·1	26·7	27·9	6·7	2·4	2·4
Mean..	For 3 trials	„	„	53·8	7·4	10·8	78·5	14·8	19·2	69·0	13·4	18·6	77·0	10·9	18·1	69·3	12·3	16·7	—	—	—
4	Time of planting ..	Katumani	1969 SR	17·8	0·0	0·1	44·3	18·3	47·3	45·4	13·1	40·3	61·6	19·8	36·5	42·3	12·8	31·1	14·1	3·1	—
5	Maize population ..	„	1969 SR	4·6	0·3	—	26·2	12·6	—	18·7	9·3	—	30·0	14·3	—	19·8	0·1	—	3·7	2·1	—
6	Time of Planting ..	„	1970 LR	36·8	8·9	20·5	96·5	38·5	40·4	75·3	32·1	39·8	117·6	41·3	34·6	81·6	30·2	33·8	9·8	4·6	6·0
7	Maize population ..	„	1970 LR	45·1	9·7	21·7	101·0	34·0	34·2	90·4	37·1	41·2	116·0	40·0	35·3	88·1	30·1	33·1	7·4	3·1	4·1
8	Maize Irrigation ..	„	1969 SR	14·8	0·3	0·7	68·8	28·7	46·5	62·7	25·7	44·8	83·3	35·7	44·6	57·3	22·6	34·2	24·2	12·6	17·5
9	Maize Irrigation ..	„	1970 LR	43·0	16·6	35·0	113·7	43·5	39·5	71·4	32·7	46·5	128·8	45·8	36·0	89·2	34·7	39·2	9·8	5·1	6·0
Mean..	For 6 trials	„		27·0	6·0	15·6	75·1	29·2	41·6	60·6	25·0	33·2	89·5	32·8	30·2	63·0	23·2	34·2	—	—	—
Mean..	For 9 trials	„		35·9	6·4	13·8	76·2	24·4	33·2	63·4	21·1	27·7	85·6	25·5	25·6	65·1	19·6	27·6	—	—	—

TABLE AGR/23—THE EFFECT OF WEEDS ON BEAN YIELD PARAMETERS

Trial No.	Name of Trial	Location	Season	W_0			W_1			W_2			W_2			W_3			Mean LSD 5%		
				TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.	TDM	GDM	C.I.
10	Time of Planting ..	K.Y.M.	69 SR*	1·1	0·1	12·9	8·8	3·3	40·5	12·0	2·9	25·2	12·9	3·9	31·5	8·7	2·6	27·5	2·8	0·8	6·8
11	Time of Planting ..	Katumani	69 SR	1·3	0·3	17·8	6·7	2·2	32·4	5·9	1·3	19·9	7·9	2·2	26·8	5·4	1·5	24·2	1·7	0·6	7·4
12	Bean Population ..	,,	69 SR	1·1	0·3	14·7	14·1	7·2	51·1	10·6	4·9	46·7	12·9	6·4	49·5	9·7	4·7	40·5	1·2	0·6	6·6
13	Bean Population ..	,,	70 LR*	16·4	10·2	63·1	45·2	27·2	60·8	33·7	20·5	61·4	46·9	28·0	59·9	35·5	21·4	61·2	3·6	2·2	—
14	Irrigation	,,	70 LR	19·4	10·8	55·8	50·3	28·1	57·0	39·2	23·4	61·0	46·0	27·8	60·0	38·7	22·5	58·7	11·1	6·4	—
15	Time of Planting ..	,,	70 LR	25·8	12·0	45·3	47·5	22·2	46·5	45·1	22·2	48·3	47·2	23·4	48·1	41·1	19·9	47·0	4·4	1·9	—
Mean	For 5 trials	,,		12·8	6·7	39·3	17·4	49·5	29·9	14·5	47·5	32·1	17·6	48·9	26·1	14·0	46·3	—	—	—	—
General	For 6 trials			10·8	5·6	34·9	28·7	18·0	48·0	24·4	2·6	43·7	28·9	15·3	46·0	23·2	12·1	43·2	—	—	—

SR*—Short Rains

LR*—Long Rains

(b) Grain Dry Matter (GDM)

Grain yields were even more significantly different, W_1 being the best on yield alone. One explanation is that there is no need for further weeding after three weeks after crop emergence at a time when a canopy develops quickly to shade the incoming weeds. Moreover further weeding may have harmful effect on the number of flowers which survive to produce mature pods.

(c) Crop Index (C.I.)

Crop index is very high for beans. This parameter was poorer in the 1969 short rains than in the long rains 1970. W_1—weeding up to three weeks had the best crop index perhaps only to confirm the weeding effect on the survival of the flowers.

Section IV: Sunflower and Soyabean—By G. M. Ravagnan

(1) *Sunflower*

Variety trials on sunflower were carried out for a second year in 1970. The main object of these experiments was to compare the improvement in seed yield of crosses between local and exotic plants versus top Kenya sunflower varieties. Furthermore other important agronomic and commercial traits as oil percentage in seed and total oil productivity per ha, were studied.

One again the statistical data, collected from different places in Trans Nzoia, have confirmed the findings of the 1969 tests and indicate that there is remarkable vigour in many of the hybrids, over both their parents. Such vigour or heterosis is chiefly manifested in greater seed yield, which in the end determines the total oil production per ha.

Results at this stage are of practical importance because the future release of superior seed, could in turn mean greater profitability from this crop. Finally a solution to the old problem of producing, under genetic control the F_1 seed from two specific parents on a large commercial scale using male sterility has been found. This will make sunflower hybrid seed production possible for the first time in tropical regions.

Plan of Experiment

Four localities were chosen in 1970 to perform a variety test for 49 entries of various cultigens of sunflower. A 7 x 7 balanced lattice design, with two replicates in each location, was used as means of adjusting the plot yield differences due to soil variation.

The size of each plot, at planting time was of 10.48 sq. metres and of 6.29 sq. metres at harvest. Competition by adjacent varieties was avoided by border row planting. Soil preparation, cultural practices and fertilization were done in identical ways and at the same time for the entire area of each experiment.

Four main group of entries can be distinguished in this experiment. A first group includes four local varieties and its improved mass selection version. A second group is of Russian varieties which were selected for high oil content of seed. An inbred from Morden, Canada, is rust resistant and partial male sterile. Finally a series of F_1 obtained by crossing CM90(RR) and local or Russian varieties, or reciprocal crosses of Russian and local varieties only.

In addition to these entries the F_2 of the crosses CM90 x KWc3 and the first cycle of a composite of 4 different origin varieties were included as checks.

Seed Yield

The increase in seed yield of most of the F_1 obtained by crossing temperate varieties (Peredovik, VNIIMK) or inbred lines (CM90, CM30) with local varieties (KW, LW, etc.) is most noticeable at first glance. As can be seen in Table S/1, the increase of seed yield goes up to 72 per cent over the best parent.

In the 1969 variety trials, carried out on 8 locations over a wide area with differing environmental conditions, the F_1 of CM90 x KWc2 and Peredovik x KWc2 increased seed yield over the best parent by 29.4 and 21.4 per cent respectively.

The greater improvement in yield of the same F_1 can be attributed both to the selection of one parent (KW(MI) c2 KW(MI) c3), together with different weather conditions during the growing season in Trans Nzoia district, last year.

Besides, the higher increase in seed yield, is generally obtained by crossing local East African and varieties from temperate regions (*see* Table S/2).

Oil content and oil yield

The total oil content produced in a sunflower crop is the product of the total seed by the oil percentage of that seed:—

$$OY = S \times O$$

(where OY is the total oil per ha—S is the total seed yield per ha and O gives the oil percentage of the seed).

Hence, the increase of either seed yield or oil content, or both, determines the increase of the total oil per hectare. Russian varieties, well-known for the high content of oil in their seed, yield poorly in tropical regions, especially in the highlands of East Africa. Most of them are affected by several kinds of diseases. However, despite low seed yield in this environment, the oil percentage remains quite high (*see* varieties Peredovik and VNIIMK 8931 in Table S/3). When these varieties are crossed with the local ones of poorer oil content, the F_1 obtained display partial or no dominance at all (Table S/2). For this reason Russian varieties grown without the necessary isolation from local varieties, or from ornamental plants of sunflower, in these regions, have lost the high oil content in a few cycles.

Nevertheless the improvement in oil percentage of such crosses over the lowest parent is still considerable (*see* Table S/2, Col. 8). It is reckoned that by recurrent selection, it will be possible to detect progenies among high oil content varieties, which exhibit complete dominance in this specific trait.

Table S/3 gives the oil percentage on a dry seed basis, the oil yield per hectare and the percentage increase in oil of the F_1 over the mean of the parents. The total oil per hectare improves, as in seed yield, notably on the crosses between Russian varieties and local sunflower populations. As can be seen in Col. 2 of that table, the hybrid L.W(MI) c3 x VNIIMK 8931 has yielded 637 kg. of oil per hectare, although the environmental conditions at harvest were not favourable. The increase in total oil of this hybrid over the best available varieties now in Kenya was 65 per cent, in the variety trials carried out in 1970.

Oil percentage increased by maternal inheritance

To investigate a possible extrachromosomal inheritance in F_1, reciprocal crosses between rich and poor oil progenies were made. In the cross VNIIMK 6540 x L.W. (MI) c2, where the mother is higher oil yielding, the F_1 is richer in oil than vice versa. Further investigations are now in progress. However, in dealing with commercial seed production it would be advisable to use Russian varieties as female parents to enhance the oil content of the seed.

Refined methods of mass selection

In Table S/1, improved varieties of sunflower are compared with the original population from where they were selected. Although genetic variability was quite high and the selection intensity used rather mild, (*see* Annual Reports 1968-69 etc.), to avoid losses of valuable characters, the improvement in seed and total oil yield is noticeable. The gain per cycle in total oil yield ranges from 17.9 per cent in KW, to 7.7 per cent in Grey/S and 16.1 per cent in Dark/S local varieties. It is expected that a further improvement in seed yield, without reduction in oil percentage, can be obtained in Russian varieties not yet adapted to this environment, if such a method of selection (head-to-row) is carried out. In addition, this kind of selection method is suitable and necessary for maintaining commercial varieties, by mild selection intensity, in this region.

TABLE S/1—SUNFLOWER EVALUATION TRIALS 1970. BALANCED LATTICE DESIGN 7×7—FOUR LOCALITIES; TWO REPLICATES; 49 ENTRIES. SEED YIELD q/ha. 10 PER CENT MOISTURE CONTENT OF THE SEED

Type of sunflower	Loc. 1 q/ha 1	Loc. 2 q/ha 2	Loc. 3 q/ha 3	Loc. 4 q/ha 4	Mean of Loc. q/ha 5
1. Armavirek	11·2	6·9	2·3	8·6	7·3
2. Peredovik (U.S.A. 1970)	11·4	11·1	7·1	9·0	9·7
3. Peredovik (Hungary)	10·5	8·3	7·0	6·8	8·2
4. Peredovik (U.S.S.R.)	11·0	10·1	21·8	7·6	12·6
5. Peredovik (U.S.A.) (MS) C1	8·4	10·0	4·6	8·0	7·7
6. VNIIMK8931 (U.S.A. 1970)	15·8	12·5	8·4	10·5	11·8
7. VNIIMK8931 (U.S.S.R. 1969)	12·7	9·0	9·2	8·3	9·8
8. VNIIMK6540	8·9	11·3	12·8	6·6	9·9
9. VNIIMK1646	10·0	9·5	21·0	7·0	11·9
10. Iregi Csikos	14·6	10·6	11·3	9·5	11·5
11. GOR–104	13·0	10·1	7·5	5·9	9·1
12. GOR–101	10·5	10·0	7·6	8·9	9·2
13. Sputnik	7·3	9·7	8·1	7·5	8·2
14. Apollo	12·4	11·4	8·1	9·7	10·4
15. K.W. (M.I.) Co	5·4	6·1	13·1	12·8	9·3
16. K.W. (M.I.) c3	13·7	8·9	12·1	17·5	13·1
17. K.W. (M.I.) c4	9·3	10·4	24·3	14·4	14·6
18. Grey/S (M.I.) c0	10·9	11·2	5·3	12·5	10·0
19. Grey/S (M.I.) c3	11·6	9·8	14·6	18·3	13·6
20. Grey/S (M.I.) c4	11·2	7·8	15·7	17·9	13·1
21. Dark/S (M.I.) c0	14·1	9·7	12·5	12·5	12·2
22. Dark/S (M.I.) c4	14·9	9·4	20·7	15·3	15·1
23. L.W. (M.I.) C2	16·5	13·9	16·4	13·7	15·1
24. C.M. 90	3·7	6·6	16·7	4·6	7·9
25. C.M. 90×Peredovik (H)	10·1	13·2	7·4	10·5	10·3
26. C.M. 90×Peredovik (U.S.S.R.)	14·7	13·2	25·2	8·9	15·5
27. C.M. 90×VNIIMK8931 (U.S.S.R.)	11·4	13·6	14·1	11·1	12·5
28. C.M. 90×VNIIMK(H)	13·6	13·2	10·4	10·1	11·8
29. C.M. 90×VNIIMK6540	14·2	13·9	8·9	11·4	12·1
30. C.M. 90×VNIIMK1646	13·2	13·3	11·7	11·0	12·3
31. C.M. 90×K.W. (M.I.) c3	18·2	19·3	31·4	21·3	22·6
32. C.M. 90×L.W. (M.I.) c2	20·9	19·1	27·1	19·1	21·5
33. C.M. 90×Comp. A. c0 (033)	13·6	16·3	9·7	12·2	12·9
34. F2 of C.M. 90×K.W. (M.I.) c3	9·9	12·0	14·1	11·6	11·9
35. C.M. 90×(L.W(MS)×K.W(M.I.) c2)	14·4	18·3	27·3	14·4	18·6
36. C.M.90× (Israel × G/S (M.I.) c2)	15·5	13·3	12·0	14·3	13·8
37. C.M. 90× (Peredovik (USA) × K.W. (M.I.) c2)	12·4	15·4	10·8	9·1	11·9
38. C.M. 30×(Pered (USA)×K.W. (M.I. c2)	15·3	12·8	17·5	11·2	14·2
39. C.M30×Comp. A. c0 (033)	10·7	13·0	19·7	9·3	13·2
40. L.W. (M.I.) c2×K.W. (M.I.) c3	13·2	14·4	26·2	17·7	17·9
41. K.W. (M.I.) c3×L.W. (M.I.) c2	15·4	13·2	19·6	17·8	16·5
42. L.W. (M.I.) c2×VNIIMK6540	16·2	16·8	20·4	16·7	17·5
43. VNIIMK6540×L.W. (M.I.) c2	17·1	14·4	18·6	17·8	17·0
44. L.W. (M.I.)×VNIIMK8931 (USA)	23.4	16·3	25·7	15·6	20·3
45. K.W. (M.I.) c3×VNIIMK (H)	21·4	15·4	19·7	16·8	18·3
46. VNIIMK (H)×Grey/S (M.I.) c3	19·7	14·6	22·0	12·9	17·3
47. Grey/S (M.I.) c3×VNIIMK (H)	14·4	13·2	19·0	15·5	15·6
48. (Israel × Grey/S (M.I.) c2) × L.W. (M.I.) c2	20·1	17·6	15·1	16·5	17·3
49. Composite A. c0(033)	15·4	14·2	17·4	12·3	14·8
Means	13·33	12·34	15·09	12·21	13·24
L.S.D. 05	4·73	4·42	9·76	3·92	4·85
C.V.	17·76	17·91	32·34	16·04	—

TABLE S/2—HYBRID VIGOUR IN F_1 CROSSES BETWEEN PARENTS OF DIFFERENT ORIGINS, IN SUNFLOWER. SEED YIELD AND CRUDE FAT, D.D. FROM EVALUATION TRIALS 1970

P_1 x P_2	P_1 q./ha. 1	P_2 q./ha. 2	Mid point of P_1 x P_2 q/.ha. 3	F_1 hybrid q./ha. 4	Heterosis Per cent 5	F_2 q./ha. 6
			Temperate x *Temperate Varieties*			
25 CM90 x Peredovik (H)	7·9	8·2	8·05	10·5	27·95	—
CM90 x Peredovik Oil D.D.%	(27·2)	(37·6)	(32·4)	(31·5)		
30 CM90 x VNIIMK1646	7·9	11·9	12·3	12·3	24·24	—
CM90 x VNIIMK1646 Oil D.D. % ..	(27·2)	(41·1)	(34·2)	(31·3)		
27 CM90 x VNIIMK8931 (USSR)	7·9	9·8	8·85	12·5	41·2	—
CM90 x VNIIMK8931 Oil D.D. % ..	(27·2)	(38·9)	(33·1)	(32·5)		
29 CM90 x VNIIMK6540	7·9	9·9	8·90	12·1	35·96	—
CM90 x VNIIMK6540 Oil D.D. % ..	(27·2)	(28·0)	(27·6)	(30·1)		
31 CM90 x KW (MI) C3	7·9	13·1	10·50	22·6	115·2	13·3
CM90 x KW (MI) C3 Oil D.D. % ..	(27·2)	(28·3)	(27·8)	(27·4)		
32 CM90 x LW (MI) C2	7·9	15·1	11·50	21·5	86·96	—
CM90 x LW (MI) C2 Oil D.D. % ..	(27·2)	(27·9)	(27·7)	(27·3)		
			Temperate x East African Varieties or Reciprocal			
42 LW(MI) C2 x VNIIMK 6540	15·1	9·9	12·5	17·5	40·00	—
LW (MI) C2 x VNIIMK 6540 Oil D.D. %	(27·9)	(28·0)	(28·0)	(30·1)		
43 VNIMK 6540 x LW (MI) C2	9·9	15·1	12·5	17·0	36·00	—
VNIMK 6540 x LW (MI) C2 Oil D.D. %	(28·0)	(27·9)	(28·0)	(34·2)		
44 LW (MI) C2 x VNIIMK 8931 (USA) ..	15·1	11·8	13·45	20·3	50·92	—
LW (MI) C2 x VNIIMK 8931 (USA) Oil D.D. %	(27·9)	(40·4)	(34·2)	(34·9)		
			East African Varieties x East African Varieties			
40 LW (MI) C2 x KW (MI) C3	15·1	13·1	14·1	17·9	29·95	—
LW (MI) C2 x KW (MI) C3 Oil D.D. %	(27·9)	(28·3)	(28·0)	(28·0)		
41 KW (MI) C3 x LW (MW) C2	13·1	15·1	14·1	16·5	17·02	—
KW (MI) C3 x LW (MI) C2 Oil D.D.%	(28·3)	(27·9)	(28·0)	(30·5)		

TABLE S/3—SUNFLOWER EVALUATION TRIALS 1970—TOTAL CRUDE OIL PER HECTARE AND PERCENTAGE OF OIL IN D.M. FOR EACH ENTRY

Type of sunflower	Crude fat D.M. Per cent 1	Total oil kg/ha. 2	Increase in oil over P of the F_1 Per cent 3
1. Armavirek	38·8	255	
2. Peredovik (USA. 1970)	36·6	319	
3. Peredovik (H)	37·6	277	
4. Peredovik (U.S.S.R)	43·8	496	
5. Peredovik (U.S.A.) (MS) c1	35·9	249	
6. VNIIMK 8931 (U.S.A. 1970)	40·4	429	
7. VNIIMK 8931 (U.S.S.R. 1969)	38·9	343	
8. VNIIMK 6540	28·0	249	
9. VNIIMK 1646	41·1	440	
10. Iregi Csikos	27·1	280	
11. GOR–104	41·0	336	
12. GOR–101	35·9	298	
13. Sputnik	34·7	256	
14. Apollo	32·1	300	
15. K.W. (M.I.) c0	26·4	221	
16. K.W. (M.I.) c3	28·3	334	
17. K.W. (M.I.) c4	28·7	377	
18. Grey/S (M.I.) c0	26·5	239	
19. Grey/S (M.I.) c3	24·6	300	
20. Grey/S (M.I.) c4	24·6	290	
21. Dark/S (M.I.) c0	23·8	261	
22. Dark/S (M.I.) c4	26·6	361	
23. L.W. (M.I.) c2	27·9	379	
24. CM90 p.m.s.	27·2	193	
25. CM90 × Peredovik (H)	31·5	292	+24
26. CM90 × Peredovik (U.S.S.R.)	28·5	398	+16
27. CM90 × VNIIMK 8931 (U.S.S.R.)	32·5	365	+36
28. CM90 × VNIIMK (H)	31·5	315	
29. CM90 × VNIIMK 6540	30·7	334	+51
30. CM90 × VNIIMK 1646	31·3	346	+11
31. CM90 × K.W. (M.I.) c3	27·4	556	+110
32. CM90 × L.W. (M.I.) c2	27·3	528	+85
33. CM90 × Comp. A. c0 (033)	31·4	365	+18
34. F2 of CM90 × K.W. (M.I.) c3	26·3	282	—
35. CM90 × (LW (MS) × K.W. (M.I.) c2)	27·9	467	
36. CM90 × (Israel × G/S (M.I.) c2)	28·8	358	
37. CM90 × (Peredovik (USA) × K.W. (M.I.) c2)	26·5	284	
38. CM30 × (Peredovik (USA) × K.W. (M.I.) c2)	27·3	349	
39. CM30 × Comp. A. c0 (033)	33·0	392	
40. LW (M.I.) c2 × K.W. (M.I.) c3	28·0	450	+26
41. K.W. (M.I.) c3 × L.W. (M.I.) c2	30·5	452	+27
42. L.W. (M.I. c2 × VNIIMK6540	30·6	482	+54
43. VNIIMK6540 × L.W. (M.I.) c2	34·2	524	+67
44. L.W. (M.I.) c2 × VNIIMK8931 (USA)	34·9	637	+58
45. K.W. (M.I.) c3 × VNIIMK (H)	31·2	531	
46. VNIIMK (H) × Grey/S (M.I.) c3	34·0	530	
47. Grey/S (M.I.) c3 × VNIIMK (H)	31·4	441	
48. (Israel × G/S (M.I.) c2 × L.W. (M.I.) c2	27·2	423	
49. Composite A. c0 (033)	32·0	426	
L.S.D. 05	2·9		
Mean	31·2	367·5	

TABLE S/4—SUNFLOWER EVALUATION TRIALS 1970—MEAN OF FOUR LOCATIONS

Type of sunflower	Lodg. plants per cent 1	Rust infest per cent 2	Days to 50 per cent flower 3	Days to harvest 4
1. Armavirec	3·2	3·7	62	111
2. Peredovik (U.S.A. 1970)	1·0	18·9	70	116
3. Peredovik (H)	2·0	16·3	75	117
4. Peredovik (U.S.S.R)	14·7	52·9	91	137
5. Peredovik (U.S.A.) (MS) c1	6·0	3·7	94	135
6. VNIIMK8931 (U.S.A. 1970)	2·9	11·8	70	114
7. VNIIMK8931 (U.S.S.R. 1969)	5·5	8·4	71	116
8. VNIIMK6540	12·6	9·0	67	111
9. VNIIMK1646	5·5	6·5	74	117
10. Iregi Csikos	4·8	1·4	74	115
11. GOR. 104	2·8	19·4	73	116
12. GOR. 101	4·2	11·8	73	121
13. Sputnik	2·0	14·5	72	121
14. Apollo	2·1	5·2	71	120
15. KW (MI) c0	18·6	8·5	122	157
16. KW (MI) c3	10·4	0·0	106	150
17. KW (MI) c4	16·8	0·0	112	153
18. Grey/S (MI) c0	9·1	12·6	100	148
19. Grey/S (MI) c3	9·1	13·4	110	150
20. Grey/S (MI) c4	7·0	2·7	111	152
21. Dark/S (MI) c0	13·3	30·2	78	119
22. Dark/S (MI) c4	17·9	14·0	97	145
23. LW (MI) c2	10·7	1·4	88	134
24. CM90 P.M.S.	2·9	3·8	71	116
25. CM90 × Pered. (H)	0·5	4·4	69	115
26. CM90 × Pered. (U.S.S.R.)	0·0	8·8	81	124
27. CM90 × VNIIMK8931 (U.S.S.R.)	1·7	3·7	73	117
28. CM90 × VNIIMK (H)	1·5	3·5	72	119
29. CM90 × VNIIMK6540	1·4	6·1	69	118
30. CM90 × VNIIMK1646	2·2	3·9	71	115
31. CM90 × KW (MI) c3	8·8	2·0	85	132
32. CM90 × LW (MI) c1	9·7	1·2	87	132
33. CM90 × Comp. Aco (033)	4·1	5·4	71	117
34. F2 of CM90 × KW (MI) c3	7·2	1·9	90	134
35. CM90 × (LW (MI) × KW (MI) c2)	6·6	9·6	81	126
36. CM90 × (Isr. × G/S (MI) c2)	3·6	1·4	76	122
37. CM90 × (Per. (USA) × KW (MI) c2	6·0	4·9	73	116
38. CM90 × (Per. (USA) × KW (MI) c2	1·2	6·9	73	121
39. CM30 × Comp. A. c0(033)	8·9	5·1	69	114
40. L.W. (MI) c2 × KW (MI) c3	13·5	2·8	96	147
41. KW (MI) c3 × LW (MI) c2	13·4	2·3	89	143
42. LW (MI) c2 × VNIIMK6540	7·4	11·3	81	125
43. VNIIMK6540 × LW (MI) c2	4·6	4·8	86	129
44. LW (MI)c2 × VNIIMK8931 (USA)	1·1	11·2	85	128
45. KW (MI) c3 × VNIIMK (H)	4·4	5·5	84	131
46. VNIIMK (H) × G/S (MI) c3	8·5	7·5	89	134
47. G/S (MI) c3 × VNIIMK (H)	6·8	9·9	91	134
48. (Isr. × G/S (MI) c2 × LW (MI) c2	4·4	3·8	87	131
49. Composite A. c0 (033)	9·9	4·9	82	130
L.S.D. 05	11·3	18·47	3·26	1·14
Mean	6·58	8·22	82	127

Table S/1 shows also the yield of the F_2 obtained by selfing the F_1 of CM90 × K.W. cross. The sharp decline in yield reflects the effect of the segregation of divergent characters of the two parents. This again confirms the superior performance of the first generation of this hybrid.

Besides, in Table S/1, is recorded the yield of a composite of sunflower, in cycle O. As mentioned in last year's report, this composite was made with varieties of different origins and traits. The aim is to increase the genetic variability of a population from which to extract superior inbred lines. It is reckoned that at least four cycles of random mating are necessary before an attempt is made to initiate a chosen method of recurrent selection.

Plant lodging and rust disease

Together with seed and oil yield data, other characters have been recorded and studied in these evaluation trials. In Table S/4 the percentage of plants lodged and the rust incidence, *Puccinia helianthi,* at the end of flowering period (number of plants affected by more than 25 per cent of rust) are given. Both of these two adversities are important in East Africa at present, as they are considered to be the most severe threat to sunflower yields. According to the results obtained from these trials, and even from previous experiments, most of the varieties introduced from temperate climates are susceptible to rust disease. On the other hand, some of the local varieties display a better rust resistance, in particular K.W. and L.W. In fact, the selection version of the latter are all improving the resistance to rust disease and they confirm again the effectiveness of the selection methods used. The inbred lines CM90 (RR), imported from Canada, possess a good resistance to rust, even in this environment. This line was used as mother on several crosses for its partial pollen sterility. Most of the F_1 of these lines are showing little rust infection (Table S/3 Col.2).

A peculiarity of the local sunflower varieties is the extreme tallness of the stem, which is regarded as the main reason for yield reduction due to plant lodging. Crossing tall varieties with exotic shorter types and height of the hybrids obtained is often intermediate. Short stem plants are required in the large-scale farms, where harvesting could be done mechanically. A further selection in both parent lines of these hybrids will improve this desirable trait.

Length of Growing Period, Head Diameter and Percentage of Secondary Heads

The recorded length of the vegetative period (Table S/3 Col. 3 and 4) is showing a reasonable variation in all the entries. It varies from 62 days, from sowing to 50 per cent of blooming, to 122 days. This inherited character, sometimes correlated with the height and yield, is quite important for the choice of the right variety in this region and climate, where one of the most yield limiting factors is moisture. In Trans Nzoia district the rainy season lasts for nearly nine months and the earliness or lateness of the maturity of the sunflower crop can play a primary role in rotation and husbandry practices. The inheritance in F_1 from parents with divergent maturity periods follows the same pattern as the height. The hybrids do not exhibit any dominance (Table S/3 Col. 3).

The head diameter, as an inherited character, behaves in a different way. Almost all of the F_1 are showing overdominance in this trait, especially when the crosses are from parents of different origin. Head diameter, as noticed in the past, on the same terms, is an indication of higher seed yield.

The F_2 generation obtained by selfing the F_1 of the cross CM90 x KW(MI) c3 illustrates the segregating effects in head diameter and the tendency to re-establish the original parent head size.

The appearance in some varieties of sunflower of secondary small heads on the main stem or in axillary branches, is an undesirable character. It reduces the yield of the crop by increasing the percentage of small and poor seed. From the data recorded in Table S/4, Col. 3, it appears that this character is recessive and can be limited to a very low percentage by uprooting these plants before they start to flower.

1000 Seed Weight and Kernel Percentage on the Total Achene Weight

The study of these characters and their possible relationship with oil percentage and seed or oil yield, if conclusive, is very useful in breeding research. Little or nothing is written on this subject in world literature, particularly with regard to sunflower crops in tropical climates. The seed weight is generally an indication of favourable environment, in particular at the ripening stage of the plants, but it is also an expression of an inherited character. The wide range of different cultigens tested in these variety trials is also reflected in the large variations of its seed weight (*see* Table 5). Bird seed varieties, like Grey/S Dark/S or L.W. requested overseas for their large size of seed, and giving a good financial return, are usually heavier in seed weight. The cross of these varieties with high oil content varieties (Peredovik etc.) which are lower in seed weight and smaller in seed size, shows an intermediate weight, which is associated with an intermediate size of seed.

The oil which is produced by a sunflower plant is concentrated entirely in kernel of the ripe seed. Practically no fat or oil is contained in the husk. The varieties with higher kernel percentage also have higher oil content. A knowledge of this positive correlation between kernel and oil percentage would make it easier to detect superior oil lines than using the slow and expensive laboratory analysis of the oil. Col. 2 of Table S/5 gives the kernel percentage out of the total achene weight of all the entries. Fig. S/1 gives the regression of oil percentage on sunflower kernel percentage.

Genetic and Cytoplasmic Pollen Sterility for Commercial Seed Production of Sunflower Hybrids

The use of male sterility in female parents for commercial production of sunflower hybrid seed is only a very recent achievement. In the past the so called "Commercial hybrids" were in fact crosses of incompatible lines or varieties which in effect were not sterile and only produced F_1 seed which were only mixture of crossed seed and some selfed seed. At present, several of the complete pollen sterile lines, transferred both in exotic and local populations of sunflower, are available at Kitale for a genuine commercial hybrid production. Some of these sterile lines were detected in our field; some were obtained by crossing and back-crossing cultivated plants with ornamental plants of sunflower; some were introduced from research institutes in Western countries and are now under observation.

At present these sterile lines can be grouped as follows according to their mode of inheritance.

(1) genetic male sterile (6 lines which apparently differ from each other in some gene loci):

(2) cytoplasmic male sterile (5 lines with their own "maintain" and "restorer" of fertility):

(3) other types of inherited male sterility (trisomic? etc.) under study (about 11 or 12 lines).

The genetic male sterile lines, most of them incorporated in high oil yielding varieties, carry a recessive gene for male sterility, ms. Once the isolated ms lines are crossed to heterozygous lines carrying ms ms alleles they segregate as 50 per cent sterile and 50 per cent male fertile in F_1. Kitale genetic sterile lines can be identified immediately before flowering, by a different bud conformations on the male sterile plants from the fertile ones of the same family. Sterile plants of Canadian origin can be identified in earlier stages in the field by different colours in the leaf mid-rib and veins. In both cases it is possible to control, quite cheaply, the cross pollination from the male fertile plant to the male sterile lines.

To propogate cytoplasmic male sterile plants, non-restorer (or maintainer) plants are required. The latter plants, when crossed with the cytoplasmic sterile ones, produce sterile F_1 plants only. The anthers of the sterile flowers are not extruded and no pollen is shed under any environmental condition. On the other hand the pistils are normal and once fertilized by ordinary pollen they produce normal seed.

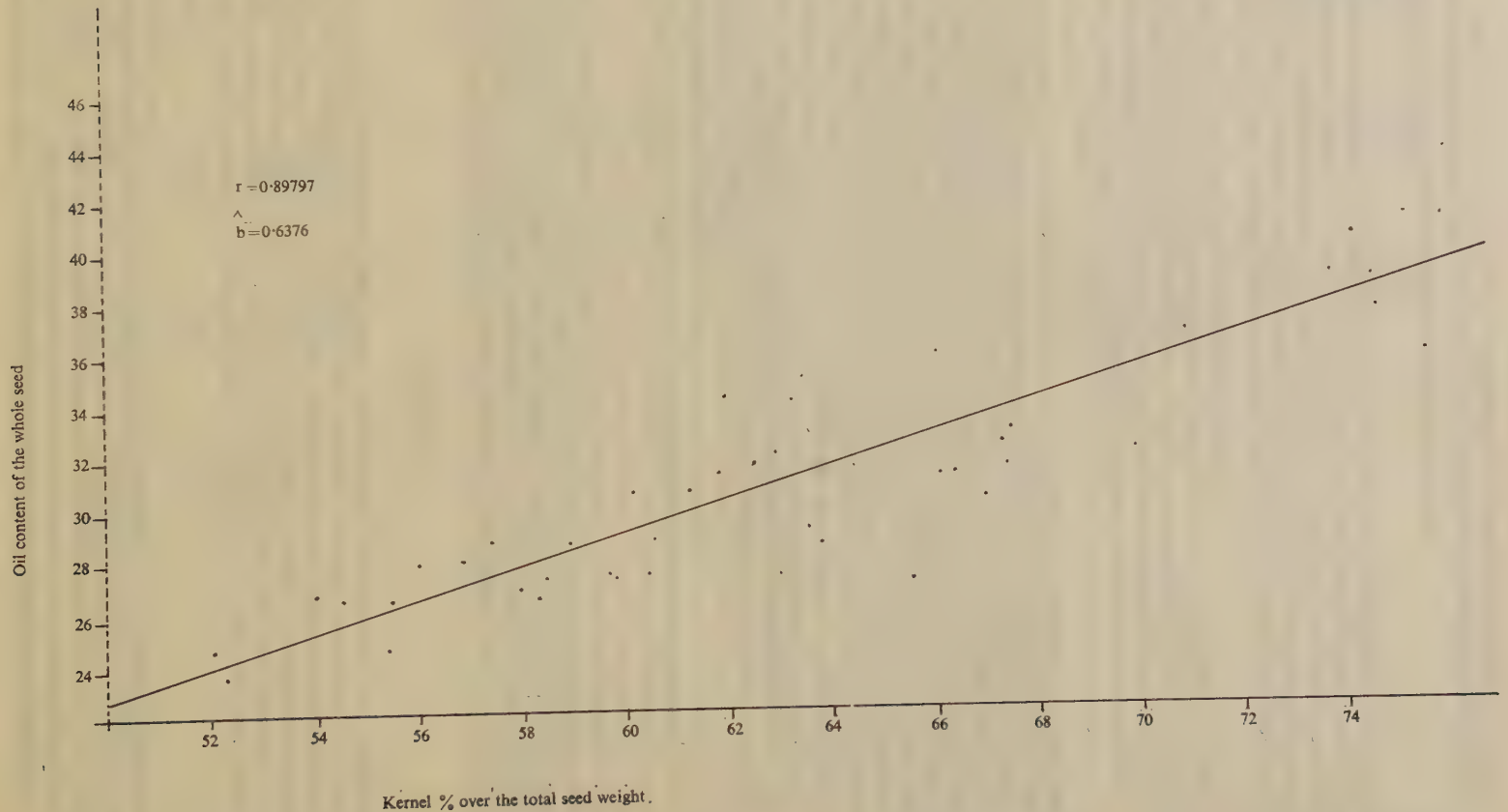
TABLE S/5—SUNFLOWER EVALUATION TRIALS 1970—MEAN OF FOUR LOCATIONS. HEIGHT, HEAD DIAMETER, MULTIHEAD CHARACTERS

Type of sunflower	Plant height cm. 1	Head diameter cm. 2	Multihead Per cent 3
1. Armavirek	150	12·79	1·9
2. Peredovik (USA. 1970)	175	13·37	0·0
3. Peredovik (H)	169	12·93	0·0
4. Peredovik (USSR)	186	13·21	0·0
5. Peredovik (USA) (MS) c1	198	12·25	0·0
6. VNIIMK 8931 (USA. 1970)	179	14·18	1·0
7. VNIIMK 8931 (USSR. 1969)	150	13·23	4·2
8. VNIIMK 6540	155	12·39	2·7
9. VNIIMK 1646	174	13·24	2·8
10. Iregi Csikos	189	13·83	2·5
11. GOR—104	171	13·11	1·4
12. GOR—101	189	13·36	1·8
13. Sputnik	170	12·52	0·0
14. Apollo	175	13·29	0·0
15. K.W. (MI) c0	310	13·94	22·6
16. K.W. (MI) c3	297	14·10	0·0
17. K.W. (MI) c4	305	13·89	1·0
18. Grey/S (MI) c0	279	14·44	2·0
19. Grey/S (MI) c3	284	14·89	0·0
20. Grey/S (MI) c4	291	13·90	0·0
21. Dark/S (MI) c0	198	14·22	0·6
22. Dark/S (MI) c4	258	14·02	0·0
23. L.W. (MI) c2	257	14·92	1·5
24. CM90 p.m.s	123	11·60	22·0
25. CM90 × Peredovik (H)	157	13·23	1·6
26. CM90 × Peredovik (USSR)	178	14·13	11·8
27. CM90 × VNIIMK8931 (USSR)	167	14·32	2·2
28. CM90 × VNIIMK (H)	172	13·66	5·2
29. CM90 × VNIIMK6540	163	14·09	2·9
30. CM90 × VNIIMK1646	164	13·72	12·3
31. CM90 × K.W. (MI) c3	240	17·19	0·7
32. CM90 × L.W. (MI) c2	234	16·39	3·8
33. CM90 × Comp. A. c0 (033)	173	14·04	5·1
34. F2 of CM90 × K.W. (MI) c3	233	12·90	1·1
35. CM90 × (LW (MS) × KW (MI) c2)	196	15·41	4·5
36. CM90 × (Israel × G/S (MI) c2)	192	14·74	4·1
37. CM90 × (Peredovik (USA) × KW (MI) c2)	175	14·25	4·0
38. CM30 × (Peredovik (USA) × KW (MI) c2)	174	14·37	1·1
39. CM30 × Comp. A. c0 (033)	161	13·33	0·0
40. LW (MI) c2 × KW (MI) c3	280	14·95	3·0
41. KW (MI) c3 × LW (MI) c2	270	14·87	0·5
42. LW (MI) c2 × VNIIMK6540	255	15·77	1·6
43. VNIIMK6540 × LW (MI) c2	256	15·52	0·0
44. LW (MI) c2 × VNIIMK8931 (USA)	246	15·45	0·0
45. KW (MI) c3 × VNIIMK (H)	262	15·04	0·7
46. VNIIMK (H) × Grey/S (MI) c3	252	14·87	0·0
47. Grey/S (MI) c3 × VNIIMK (H)	259	14·60	0·0
48. (Israel × G/S (MI) c2) × LW (MI) c2	263	15·64	0·0
49. Composite A. c0 (033)	216	13·75	0·0
L.S.D. 05	21·08	1·33	5·8
Mean	212	14·08	2·7

TABLE S/6—SUNFLOWER EVALUATION TRIALS 1970. KERNEL PERCENTAGE OVER TOTAL WEIGHT OF THE SEED. 1,000 SEEDS WEIGHT

Type of sunflower	Kernel Per cent 1	1,000 seeds weight grm. 2
1. Armavirek	74·0	80·40
2. Peredovik (USA. 1970)	74·6	66·67
3. Peredovik (H)	74·6	67·73
4. Peredovik (USSR)	76·1	61·10
5. Peredovik (USA) (MS) c1	66·1	63·37
6. VNIIMK 8931 (USA. 1970)	74·4	75·60
7. VNIIMK 8931 (USSR. 1969)	73·7	70·53
8. VNIIMK 6540	65·6	79·87
9. VNIIMK 1646	75·7	64·43
10. Iregi Csikos	63·6	64·93
11. GOR—104	75·2	65·43
12. GOR—101	75·6	65·23
13. Sputnik	70·9	59·10
14. Apollo	69·9	60·37
15. K.W. (MI) c0	55·4	77·60
16. K.W. (MI) c3	59·1	79·53
17. K.W. (MI) c4	57·5	84·73
18. Grey/S (MI) c0	54·5	91·67
19. Grey/S (MI) c3	52·1	88·07
20. Grey/S (MI) c4	55·4	86·83
21. Dark/S (MI) c0	52·4	92·50
22. Dark/S (MI) c4	54·1	92·77
23. L.W. (MI) c2	56·1	101·17
24. CM90 p.m.s.	63·1	64·85
25. CM90 × Peredovik (H)	67·4	70·43
26. CM90 × Peredovik (USSR)	63·9	69·00
27. CM90 × VNIIMK8931 (USSR)	67·4	70·77
28. CM90 × VNIIMK (H)	66·4	72·50
29. CM90 × VNIIMK6540	67·0	71·03
30. CM90 × VNIIMK1646	66·2	76·47
31. CM90 × KW (MI) c3	57·7	88·20
32. CM90 × L.W. (MI) c2	58·4	92·47
33. CM90 × Comp. A. c0 (033)	64·4	77·30
34. F2 of CM90 × K.W. (MI) c3	57·9	92·50
35. CM90 × (LW (MS) × KW (MI) c2)	58·4	96·20
36. CM90 × (Israel × G/S (MI) c2)	60·5	70·47
37. CM90 × (Peredovik (USA) × KW (MI) c2)	58·3	71·80
38. CM30 × (Peredovik (USA) × KW (MI) c2)	60·4	78·20
39. CM30 × Comp. A. c0 (033)	67·5	75·10
40. LW (MI) c2 × KW (MI) c3	56·8	96·40
41. KW (MI) c3 × LW (MI) c2	61·1	85·90
42. 42. LW (MI) c2 × VNIIMK6540	61·2	97·33
43. VNIIMK6540 × LW (MI) c2	61·9	80·13
44. LW (MI) c2 × VNIIMK8931 (USA)	63·4	78·73
45. KW (MI) c3 × VNIIMK (H)	61·7	75·87
46. VNIIMK (H) × Grey/S (MI) c3	63·2	80·60
47. Grey/S (MI) c3 × VNIIMK (H)	62·5	75·50
48. (Israel × G/S (MI) c2) × LW (MI) c2	58·8	82·50
49. Composite A. c0 (033)	62·8	81·40
L.S.D. 05	—	9·55
Mean	64·17	77·86

Figure S/1 — Sunflower evaluation trials 1970—Relationship between kernel per cent over the total seed weight and the oil content of the whole seed. 49 entries.



However, in commercial seed production a partial or total fertility is required in F_1. Lines with fertility restorers are necessary to set the seed in the commercial hybrid heads. At Kitale, several inbred lines from local varieties have been isolated with restorer gene for pollen fertility. Now, as most of our local varieties of sunflower are used as male parents of these crosses, this fact will speed up the commercial production of such a type of seed.

Conclusion

From the results obtained in these breeding experiments at Kitale last year, more substantial evidence on the hybrid vigour in seed yield of sunflower has emerged. For these reasons and because of the fact that male sterility in most of local varieties and inbred lines is now available, we believe that nothing can now hinder the practical use of hybrid seed in sunflower. By moving in this direction it would be possible, in a very short period of time to increase significantly vegetable oil production in this country.

(ii) *Soya bean*

Due to staff and funds limitation the soya bean programme carried out previously by Mr. S. K. Njuguna was temporarily suspended in 1970. Only varieties like Hill and Belgian Congo have been bulked on the Station and the seed stored for field trials to be carried out in 1971. All entries and valuable germ plasm has been preserved in the Maize Research Section cold store.

Section V: Development Beyond the Research Station—F. Ogada

(a) Seed Production and Distribution

The breeding and the development of high yielding varieties at the research station could be a worthless effort and a waste of time if the high yield potential varieties did not somehow find their way to the farmers for whom the work is done. The important task of producing hybrid seed began in 1963 when the first hybrids were developed. The Kenya Seed Company undertook the hybrid seed production then and, despite problems here and there, has competently coped with this vital link in the development of hybrid maize in Kenya. The development of a strong seed certification scheme has ensured that only high quality seed, by international standards, was produced, distributed and sold to the Kenyan farmers. From the early days the certification scheme was run by the Maize Research Section and this involved more and more staff and other resources of the section being devoted to this service as the hectarage to be inspected and certified increased year after year. It was soon apparent that research work on the station would suffer if a separate government agency was not instituted to carry on with the service.

The Kenya Inspection Services for Seeds (K.I.S.) took over the maize seed certification scheme from the Maize Research Section in 1970. This was a timely move as the unprecedented expansion in the seed production industry demanded far greater attention than could be offered by the Maize Research Section without sacrificing the high standards that had fortunately been maintained to date.

The development in the hybrid maize production has not only meant the setting up of a special inspection service by the Government but also that the Kenya Seed Company, with its obvious commercial interest, has had to employ more staff for its expanded production and sales promotion programmes. The company has set up a large distribution network all over the country so that farmers can get their seed within easy reach.

(b) Extension effort and the adoption of the improved practices

The rapid expansion in the hectarage grown for hybrid maize seed production; the expansion in the Kenya Seed Company and its seed distribution network; and the

TABLE V/1—HYBRID SEED MAIZE PRODUCTION IN KENYA—1963–1971*

Year	Total No. of hectares allocated	Total No. of hectares certified	Total production in 90 kg. bags	No. of seed Growers
1963	128	115	2,951	26
1964	210	203	8,056	29
1965	442	421	10,564	39
1966	1,258	1,226	44,350	78
1967	712	678	25,370	57
1968	517	489	19,531	46
1969	957	938	33,149	59
1970	1,620	1,620	55,500	61
1971*	2,880	—	89,600*	67

*Estimated.

setting up a Government seed inspection services are all a part of a chain of events dictated by the demand of the Kenya maize grower for improved seed. The fantastic rate at which the farmers took up the hybrid seed from the early days has been attributed to the effective use of method and result demonstration plots snowing a package of recommendations with good husbandry practices using hybrid seed. The extension staff who organized these demonstration plots deserve credit for the successful effort. It has been argued, perhaps rightly, that the early adopters of hybrid seed with good practices, were the better farmers and who were at a higher level of farming and who stood to benefit immediately. If this is true then maize being as important as it is nationally then greater efforts will be required to continue pushing hybrid maize to the remaining high potential maize areas mainly in the small scale farming sector. Indications in the past 2 or 3 years, Table V/2, are that extension pressure is still on and that the expansion is greater than even the most optimistic forecasts.

(c) Demonstration plots—impact on the population

The success in popularizing hybrid maize and the adoption of the improved practices for growing maize in Kenya has been attributed to the use of effective and carefully organized method and result demonstration plots. The Ministry of Agriculture realized, soon after the release of the first hybrids in 1964, that something would have to be done to get the seed to the bulk of the Kenya farmers particularly the small scale farmers who were not used to paying a high price for their seed maize. It required a big effort, to say the least, to try and convince these small farmers that it was worthwhile spending money on hybrid seed.

TABLE V/2—HECTARES OF HYBRID MAIZE GROWN IN 1963–1971*
(ESTIMATED FROM SEED SALES).

Year	Large Scale Farms	Small Scale Farms	Total
1963	156	4	160
1964	11,480	700	12,180
1965	21,880	8,016	29,896
1966	25,560	15,092	40,652
1967	54,856	46,100	100,956
1968	36,478	50,720	87,198
1969	39,042	63,540	102,582
1970	45,364	95,779	141,143
1971	48,000	152,000	200,000

*Estimated.

TABLE V/3—COMMERCIAL VARIETIES AND HYBRIDS CURRENTLY AVAILABLE

Hybrid or variety	Year of first Release	Pedigree	Maturity classification
Katumani composite B	1967	Variety cross Kat. Syn IV × Syn V	Early (4–5 months)
H 511	1967	Variety cross Embu 11 × Embu 12	Medium (5–6 months)
H 512	1970	S.R. 52 × H 511	Medium (5–6 months)
H 622	1965	Double cross (G × D) × (A × F)	Late (6–8 months)
H 632	1965	Three way cross (A × F) × G	Late (6–8 months)
H 612	1966	Single cross × variety (A × G) × Ec. 573 c0/c2	Late (6–9 months)
H 613B	1967	Single cross × variety (F × G) × Ec. 573 c0/c2	Late (6–9 months)
H 611C	1971	Synthetic × variety Kit. Syn. III × Ec. 573 Rc2	Late (6–9 months)

The organization and campaign started towards the end of 1964 and the idea was to plant one acre demonstration plots with carefully selected farmers and within walking distance of the neighbouring farmers. The detailed supervision was in the hands of the local agricultural instructors and this covered everything from land preparation to harvest. All the operations were done in the presence of farmers and small field days were held so that the farmers could see for themselves how the new maize "hybrid" was to be grown. In 1965 over 5,000 of these one-acre demonstration plots were grown all over the country. The impact of these original demonstration plots was felt and the following years they continued to be grown in the maize-growing areas. In every case only improved maize was used in these, be it hybrid or Katumani maize. The detailed operations differed slightly in the different areas but the theme of putting over the whole "package" of recommended practices remained the same.

In the past few years the pattern of organization of these plots have changed slightly with more emphasis on popularizing the use of fertilizers to increase productivity. This latter type of demonstration was started by F.A.O. experts and has used several other crops in addition to maize. The emphasis on good husbandry even on these fertilizer demonstration plots has not been ignored as this was recognized as the major complex contributing to the low crop yields in Kenya.

There is, however, one other type of demonstration which has not received as much mention and recognition as it deserves and that is the types that are regularly organized by the Maize Research Section and sent out to institutions such as F.T.C.s, training colleges and schools. These demonstrations show not only the range of varieties and the highlight of the maize breeding programmes in Kenya but the simple good and bad husbandry practices in maize-growing. The demonstration kits are prepared at Kitale and are sent out to the various institutions every year. In 1970 there were requests for more than 100 kits. With the inclusion of agriculture in the secondary schools curriculum it is likely that the demand will increase and the positive impact of these on the younger generation is expected to produce a very desirable long term effect.

FESTUS OGADA,
Senior Maize Research Officer.

II—PASTURE RESEARCH SECTION

A.—Weather

During 1970 the rains started earlier than usual. January and March were wet months with rainfall well above normal. February rains were however much below normal. The rains were well distributed in April, May, June, July and August but from October onwards the rains were not effective. Table I gives details of rainfall distribution.

TABLE I—RAINFALL DISTRIBUTION, 1970

MONTH	Rainfall (mm.)	10 years Mean
January	105·7	17·3
February	8·7	53·9
March	226·4	92·4
April	144·4	161·9
May	136·2	165·0
June	88·7	92·3
July	177·3	149·7
August	205·1	182·8
September	86·1	103·4
October	82·7	117·8
November	32·4	99·8
December	13·6	50·2
TOTAL	1609·7	1286·5

B.—Report on Experiments

(i) SPECIES INTRODUCTION AND TESTING—(E. Mwakha)

The pasture species testing programme initiated in 1967 was wound up at the end of 1970. Nine grass and seven legume varieties were planted and evaluated visually at twenty-five sites in western and central Kenya. It was observed that Rhodes grass varieties Mbarara, Pokot and Masaba in mixture with *Desmodium uncinatum* and *Desmodium intortum* established best in areas within the altitudinal range of 1,100 metres and 1,800 metres. For areas between 1,800 metres and 2,100 metres Nandi Setaria in mixture with Kenya White Clover or Louisiana White Clover was the most promising.

The dry matter and crude protein quality of Bungoma grass (*Entolasia imbricata* Stapf.) were compared with Nandi Setaria, Makueni Guinea and Solai Coloured Guinea grasses in a spaced plants experiment. Table II gives the results of twelve months of sampling.

The results showed highly significant differences between species in dry matter production at various frequencies and heights of cutting. More frequent cutting resulted in lower dry matter production but of higher crude protein content, whereas less frequent cutting gave more dry matter yields but the crude protein content was inferior to the more frequently cut herbage. The highest dry matter yields of the four species was achieved when the herbage was cut every eight weeks and at the lowest height of 5 cm. above the ground.

Two fodder grasses, i.e. Napier grass cv. French Cameroons and Guatemala grass, were grown for sixteen months during which they were subjected to two, four and eight months cutting frequencies. The leaf and stem dry matter yields and their crude protein contents were determined. The results are summarized in Table III.

TABLE II—DRY MATTER YIELDS AND CRUDE PROTEIN CONTENTS OF FOUR GRASSES AT VARIOUS FREQUENCIES AND HEIGHTS OF CUTTING

Cutting Frequency (Weeks)	Cutting Height (CM.)	Species	Dry Matter (Tonnes/ Ha.)	Crude Protein Percentage
2	5	*Entolasia imbricata*	1·36	36·6
		Setaria sphacelata	2·29	27·8
		Panicum maximum	4·65	24·1
		Panicum coloratum	2·53	28·0
	15	*Entolosia imbricata*	3·30	27·7
		Setaria sphacelata	7·98	25·7
		Panicum maximum	10·82	20·5
		Panicum coloratum	6·16	26·3
	25	*Entolasia imbricata*	3·63	22·0
		Setaria sphacelata	9·94	23·1
		Panicum maximum..	12·74	18·8
		Panicum coloratum	9·81	25·2
4	5	*Entolasia imbricata*	4·51	31·1
		Setaria sphacelata..	7·05	23·8
		Panicum maximum	15·32	19·3
		Panicum coloratum	8·07	22·1
	15	*Entolosia imbricata*	6·37	23·5
		Setaria spachelata	11·54	20·5
		Panicum maximum	17·55	17·7
		Panicum coloratum	12·73	20·6
	25	*Entolasia imbricata*	6·61	20·6
		Setaria sphacelata	12·54	19·3
		Panicum maximum..	18·43	16·1
		Panicum coloratum	14·49	19·4
8	5	*Entolasia imbricata*	8·91	22·0
		Setaria sphacelata	16·15	16·5
		Panicum maximum..	25·98	13·2
		Panicum coloratum..	18·02	13·7
	15	*Entolasia imbricata*	7·03	17·4
		Setaria sphacelata	18·70	15·0
		Panicum maximum..	23·25	12·5
		Panicum coloratum	19·09	13·7
	25	*Entolasia imbricata*	6·50	16·3
		Setaria sphacelata	17·28	14·4
		Panicum maximum..	20·75	12·1
		Panicum coloratum	18·60	13·9

L.S.D. (0·01) between species means=0·42.

L.S.D. (0·01) for interaction effects=2·12

Table III—Dry Matter Yields and Crude Protein Contents of Leaves and Stems of Napier and Guatemala Grasses

Fodder Grasses	Cutting Frequency (Months)	Leaf Dry Matter (Tonnes/ha)	Leaf Crude Protein Per cent	Stem Dry Matter (Tonnes/ha.)	Stem Crude Protein Per cent
Napier Grass	2	15·2	13·8	7·2	8·4
	4	13·7	11·0	17·8	5·2
	8	10·5	8·7	37·3	2·8
Guatemala Grass	2	11·2	13·7	0·0	—
	4	17·0	9·7	1·7	6·3
	8	17·1	8·3	9·1	5·7

L.S.D. (0·05) for leaf dry matter=2·6

Napier grass outyielded Guatemala grass in total dry matter production at all the frequencies of cutting in the trial. The total dry matter, stem dry matter, proportion of stem in total dry matter and herbage growth height of both fodder grasses increased with the decrease in cutting frequency. On the other hand the leaf dry matter, leaf crude protein and stem crude protein contents declined with the reduction in cutting frequency. More frequent cutting favoured maximum production of utilizable dry matter of leaf of Napier grass while less frequent cutting favoured the leaf production of Guatemala grass.

Freshly harvested seed of Bungoma grass was stored for two, four and six months in cold storage at 5-10°C, on the office bench at 20-25°C and in an incubator at 35-40°C. The results of germination tests carried out on the seeds are shown in Table IV.

Table IV—Germination of Bungoma Grass Seeds at Different Storage, Temperatures and Durations

Storage Chamber	Storage Duration (Months)	Germination (Per cent P.G.S.)
Cold Store (5–10°C)	2	9·5
	4	4·8
	6	14·2
Office Bench (20–25°C) ..	2	11·8
	4	12·9
	6	27·8
Incubator (35–40°C)	2	32·3
	4	44·6
	6	42·8

L.S.D. (0·01) between treatment means=11·5 per cent P.G.S.

The statistical analysis of results showed that cold storage and office temperatures did not break the seeds post-harvest dormancy within the initial four months of storage. But when storage was extended for six months there was significant increase in seed germination. Maximum germination was obtained when the seeds were stored in the incubator at 35-40°C for four months.

Seeds of Bungoma grass were mixed thoroughly with Kitale's sandy loam soil and allowed to germinate and grow for six weeks. The epicotyl lengths were measured to determine the depth from which the seedlings emerged. The results on the depth of germination are given in Table V.

TABLE V—DEPTH AND EMERGENCE OF BUNGOMA GRASS SEEDLINGS

Planting Depth (mm.)	Number of Emerged Seedlings	Per cent of Optimum Emergence
0–10	96	100·0
11–20	68	70·4
21–30	50	51·4
31–40	42	43·4
41–50	33	33·8
51–60	26	26·5
61–70	16	16·1
71–80	9	9·1
81–90	4	4·4
91–100	1	1·0
101–110	1	1·0

The analysis of the number of emerged seedlings in relation to the depth at which the seeds were placed showed a high negative linear correlation ($r = -0.96$). The optimum depth of seedling emergence was found to be within the top 10 mm. of the soil.

A trial to determine the optimum seed rates of Bungoma grass and Nandi Setaria is in progress. Initial results indicate that Bungoma grass at 8.0 kg pure germinating seed per hectare may provide a herbage cover similar to that of about 1.0 kg pure germinating seed per hectare of Nandi Setaria. The latter is the recommended seed rate for establishment of Nandi Setaria ley.

Ten grass varieties (Mbarara Rhodes, Pokot Rhodes, Masaba Rhodes, Solai Coloured Guinea, Bungoma Grass, Nandi Setaria, Kitale Molasses, Makueni Guinea, Star Grass and Congo Signal) and four legume varieties (*Desmodium uncinatum, Desmodium intortum,* Kenya White Clover and Lousiana White Clover) were planted on vlei soil as two separate trials, each replicated four times. Waterlogging rendered the site inaccessible for herbage sampling but visual evaluation indicated that Solai Coloured Guinea and Bungoma Grass among the grasses, and *D. intortum* and *D. uncinatum* among the legumes were the best varieties adapted to growing on waterlogged soils.

(ii) GRASS SEED RESEARCH—(J. G. Boonman)

In the previous Annual Reports it was indicated that row width, harvesting time and rate of nitrogenous fertilizer are the major determinants of seed yield in tropical grasses in Kenya. It was also shown in Annual Report 1968 that nitrogen (N) applied after Initial Head Emergence (I.H.E.) had no effect at all on increasing seed yield. For instance, it was found that 150 kg/ha of clean seed was obtained by applying 68 kg N soon after the onset of the rains. The corresponding split application, i.e. a total of 136 kg N divided into 68 kg applied after the onset of the rains and 68 kg seven weeks later, resulted in a yield even somewhat lower than the 68 kg straight application.

To elucidate the apparent inefficiency of late applied N an investigation was set up in 1969 to study the effect of delayed N application on seed yield in *Setaria sphacelata* cv. Nandi II. The trial was laid out in a commercial field that had been planted in 1968.

The layout was a randomized block design with 5 treatments in 5 replicates. Each plot consisted of 5 rows of 4 m. long with 50 cm. discard at the ends; only three middle rows were used for observations. Row width was 75 cm. Old herbage was removed on the 14th of April 1969 and 80 kg/ha P_2O_5 was applied. On the same day 100 N was applied to the first treatment, Tc. The other applications followed at 2-weekly intervals, but the last treatment, T_0, did not receive N at all. The first crop was harvested and all herbage removed on 1st August 1969. The same treatments were again applied this time at three-weekly intervals from 2nd August onwards.

Results of the first crop harvested 1st August 1969 are shown in Table VI.

The pattern of tillering of the first crop is shown in Table VI. Numbers declined rapidly in Tc and T_0. In the delayed applications, Tc + 2, Tc + 4 and Tc + 6 the decline in numbers of non-heading tillers was less pronounced, apparently due to the intermittent N-supply which may either have encouraged the new formation of tillers or slowed down the death rate.

The time of I.H.E. was almost identical in all treatments, indicating that time of N application had no effect on time of I.H.E. in this crop. On 27th June Tc produced twice as many heads as the other treatments that differed little from T_0. Consequently heading was most rapid at Tc.

The yield of dry matter at harvesting time declined also with delayed N-application and was lowest at T_0. Delayed N application also reduced mean head length at I.H.E. and resulted in a less pronounced decline in mean head length over the subsequent sampling dates. This may be correlated with the less pronounced decline in tiller numbers in these treatments as noted above.

The yield of clean seed was 10 per cent higher at Tc than at $Tc+_2$ and nearly 100 per cent higher at Tc than at $Tc+_4$. The treatment with the latest N application, 6 weeks after the cleaning cut, $Tc+_6$, yielded as little as T_0 that had had no N. As I.H.E. was observed in all treatments at the same date and because maturation appeared to be even in all treatments it was not necessary to carry out the harvesting at subsequent dates in accordance with the intervals of N application.

The percentage clean seed and 1,000 grain weight also tended to be highest at Tc. The same applied to the Crop Index, i.e. the percentage of seed yield against total dry matter yield, was highest at Tc, indicating that early N application favoured seed yield more than dry matter yield.

Results of the second crop, harvested 26th November, 1969 are shown in Table VII.

In the second crop a head count was carried out on 29th October and no other observations were conducted until the time of harvesting.

Heading was clearly earlier at Tc and at harvesting time head numbers were 60 per cent higher at Tc than at $Tc+_3$. Since heading started earlier in Tc it is likely that the harvesting time of 26th November was too early for the delayed N applications. However, weather was very dry in September, October and November which are usually the months of the beginning of the dry season. It therefore follows that no adequate seed crop could have been produced by the delayed N applications even if the harvesting had been carried out later. Due to the dry weather crop performance was poor even at Tc although it outyielded all other treatments. This is reflected in the Crop Index which declined with delayed N application indicating that seed yield suffered more from late N application than the dry matter yield.

Conclusion

Topdressing with N is most efficient if carried out as early as possible in the growing season. It is important to clear the first seed crop early in order to leave a sufficiently long period of the rainy season for the benefit of the second seed crop.

TABLE VI—RESULTS OF THE FIRST CROP, 1ST AUGUST, 1969

Time of N-application	no/m² of Non-Heading Tillers				no/m² of Heads			Mean Head Length (cm)			Total length of head (m/m²)	Yield of dry matter (kg/ha)	Yield of clean seed (kg/ha)	Per cent clean seed	1,000 grain weight	Crop index
	30/4	13/6	11/7	1/8	136	27/6	1/8	13/6	11/7	1/8						
Tc14/4	2,020	1,040	430	250	10	150	150	19·0	17·6	14·7	22·1	10,140	81	74	385	0·80
Tc+2 28/4 ..	1,740	1,500	760	300	20	70	90	18·8	17·8	16·2	15·2	9,260	72	68	384	0·78
Tc+4 12/5 ..	1,580	1,240	1,110	580	10	70	100	18·9	18·6	17·4	17·4	9,080	43	68	382	0·47
Tc+6 26/5 ..	2,010	1,200	1,200	620	10	60	110	17·5	16·8	15·8	17·4	7,020	29	66	360	0·41
T (no N applied)..	1,770	1,190	870	430	10	70	110	14·7	15·7	15·1	16·6	5,260	30	69	360	0·57
C.V. per cent ..	19·0	23·2	17·3	42·7	—	35·6	51·9	12·7	9·0	9·3	—	17·1	22·8	8·5	6·7	26·6
Source of variation, T.. ..	ns	ns	**	*		**	ns	*	ns	ns		**	**	ns	ns	**

TABLE VII—RESULTS OF THE SECOND CROP, 26TH NOVEMBER, 1969

Time of N Application	no/m² of heads at I.H.E.	no/m² of heads at harvesting time	mean head length (cm)	Total length of head (m/m²)	Yield of dry matter (kg/ha)	Yield of clean seed (kg/ha)	Percentage clean seed	1,000 grain weight (mg.)	Crop index
Tc 2/8 ..	29	61	14·9	9·1	6,030	32	60	358	0·53
Tc+3 23/8 ..	8	37	14·1	5·2	4,950	21	54	344	0·42
Tc+6 13/9 ..	8	16	14·9	2·4	4,290	9	59	359	0·21
Tc+9 4/10 ..	8	13	12·2	1·5	4,080	4	43	364	0·10
To no N applied	3	8	12·9	1·1	2,270	3	44	342	0·10
C.V. Percentage		31·5	6·8	29·4	17·8	47·3	21·5	6·7	30·9
source of variation, T ..	**	**	**	**	**	**	ns	ns	**

(iii) Herbage Production—(D. M. Thairu and N. C. O. Keya)

(a) Oversowing improved pasture legumes in Hyparrhenia grasslands of Western Kenya—(N.C.O.K.)

A major study was initiated in 1969 aimed at the introduction of better grazing pasture species in natural grassland at Kitale, Western Kenya. The objectives of this study were as follows:—

(1) To determine the suitability of the main improved grasses and legumes available for introducing in natural grassland by surface sowing.

(2) To ascertain the fertilizer requirements necessary to ensure good establishment and subsequent production of the introduced pasture species.

(3) To evaluate various methods of pre-treatment of natural grassland to ensure successful establishment of introduced pasture species.

A precis of the principal findings of these agronomic clipping trials is presented in this report.

Botanical composition at experimental site

The experimental site was devoid of big trees and supported a *Hyparrhenia* dominated grassland which had been occasionally topped or grazed in the past. *Hyparrhenia dissoluta, H. filipendula* and *H. cymbaria* constituted 35-40 per cent of the cover. *Digitaria maitlandii, D. diagonalis* and *D. scalarum* constituted 14-16 per cent of the cover. The other species present included *Eragrostis racemosa, E. tenuifolia, Paspalum commersonii, Brachiaria soluta, B. brizantha, Sporobolus pyramidalis* and *Loudetia kagerensis*. There were also occasional plants of *Rhynchelytrum repens, Setaria trinervia, S. sphacelata* and *Cynodon dactylon*.

Commelina benghalensis was the commonest herb. *Trifolium semipilosum* was the only indigenous legume present. Of the sedges, *Cyperus* spp. was the commonest.

Establishment of oversown improved species was assessed by:—

(1) Seedling counts using frame quadrats.

(2) Botanical changes using an inclined point quadrat.

(3) Dry matter estimation and crude protein determination.

Suitability of improved species for oversowing

Four tropical legumes (*Desmodium uncinatum* Jacq., *D. intortum* Urb., *Trifolium semipilosum* Fres. and *Stylosanthes gracilis* H.B.K.) and four grasses (*Chloris gayana* Kunth., *Panicum maximum* Jacq., *Setaria sphacelata* (Schumach) Stapf. and *Cynodon dactylon* (L) Pres. were oversown in closely grazed *Hyparrhenia/Combretum* natural grassland and top-dressed with single superphosphate at the date of 500 kg per hectare.

Grasses

The grasses (except *C. dactylon*) germinated but later died out. *C. dactylon* did not germinate throughout the period of the trial. The analysis of soil samples from the experimental site prior to oversowing showed that the soil pH ranged from 5.6 to 5.8 The soil contained 2-10 ppm phosphate and 0.16-0.24 per cent nitrogen. The preponderance of natural grasses such as *Hyparrhenia* spp., *Loudetia kagerensis* and *Eragrostis* spp. at the experimental site suggested that the soil fertility status was low. It is possible that N fertilization might have aided the establishment of the oversown grasses. The failure of the oversown grasses is also attributed to the fierce competition from existing cover. In other trial it was shown that for improved grasses to establish, some form of cultivation was necessary. Suckling (1965)* observed that oversowing improved grasses in New Zealand's hill country was successful only when delayed until the legumes established strongly and raised the soil fertility status.

Legumes

The botanical changes of legumes oversown in closely grazed unimproved grassland are presented in Table VIII.

TABLE VIII—CHANGES IN BOTANICAL COVER OF LEGUMES OVERSOWN IN NATURAL GRASSLANDS

LEGUME	PER CENT COVER OF OVERSOWN LEGUMES				
	MONTHS AFTER OVERSOWING				
	4	7	10	13	14
Desmodium uncinatum	4·8*a***	13·7*a*	32·4*a*	52·7*a*	55·1*a*
Desmodium intortum	5·7*a*	14·6*a*	31·7*a*	49·0*a*	52·6*a*
Trifolium semipilosum	0·5*b*	8·4*ab*	29·5*a*	43·9*a*	39·9*b*
Stylosanthes gracilis	0·1*b*	3·5*b*	15·6*b*	28·5*b*	27·0*c*
S.E. of the mean	±0·06	± 0·09	±0·10	±0·10	±0·07
Coeficient of variation per cent ..	26·0	9·4	5·8	4·3	3·7

**Means bearing a similar letter in the same column do not differ significantly at the 1 per cent probability level according to Duncan's multiple range test.

Data subjected to arcsine transformation prior to statistical analysis.

*Suckling F.E.T. (1965) Hill Pasture Improvement.

Newton King Group and D.S.I.R. Publication.

There were no significant differences between the botanical cover of *D. uncinatum* and *D. intortum* over the sampling period. The *Desmodium* spp. consistently covered a significantly greater area than *S. gracilis* (P=0.01). The cover of *T. semipilosum* tended to be intermediate between that of the *Desmodium* spp. and *S. gracilis.*

It was suggested from this study that improved legumes especially the *Desmodium* spp. could be established in the *Hyparrhenia* grasslands of Western Kenya by oversowing seed and topdressing with single superphosphate. Such oversown legumes led to significant increases in herbage quality and yield.

Effect of phosphatic fertilizer on the establishment of oversown legumes

The four tropical legumes mentioned above were oversown in unimproved grassland in the presence or absence of 105 kg per hectare P_2O_5. The phosphate was applied as single superphosphate (21 per cent P_2O_5; 10 per cent S).

The total dry matter (DM) and crude protein (CP) yields (4 cuts) of natural grassland oversown with tropical legumes are presented in Tables IX and X respectively.

TABLE IX—TOTAL DRY MATTER PRODUCTION 16 MONTHS AFTER OVERSOWING NATURAL GRASSLAND WITH LEGUMES IN THE PRESENCE OR ABSENCE OF P.

Legume	Kg./ha dry matter		Mean
	Kg/ha P_2O_5		
	0	105	
No legume	3,671*f**	4,477*de*	4,074
Stylosanthes gracilis	4,303*e*	5,805*c*	5,054
Trifolium semipilosum	4,781*d*	7,555*b*	6,168
Desmodium uncinatum ..	4,150*e*	8,230*a*	6,190
Desmodium introtum	4,763*d*	7,673*b*	6,218
Mean	4,334	6,748	—

S.E. of the Mean $=\pm 40{\cdot}7$ kg.
Coeficient of variation $=2{\cdot}5$ per cent.

*Means followed by the same letter do not differ significantly at the 5 per cent probability level according to Duncan's multiple range test.

In the final harvest taken about 16 months after oversowing, *S. gracilis, T. semipilosum, D. intortum* and *D. uncinatum* in the P plots contributed 18, 26, 52 and 64 per cent, respectively, of the total DM produced. In the absence of P, *D. intortum, S. gracilis, T. semipilosum* and *D. uncinatum* constituted 1, 2, 6 and 12 per cent, respectively, of the DM in the final cut. Application of P alone did not appreciably increase the productivity and quality of unimproved grassland. But the interaction between the oversown legumes and phosphatic fertilizer was significant. Application of P doubled the total DM and almost trebled the total CP yields of *D. intortum* and *D. uncinatum* plots in natural grassland 16 months after oversowing. Oversown legumes in the P plots increased the CP content of the DM significantly. Whereas the DM in the control plots contained 6.3 per cent CP, the DM from *S. gracilis, T. semipilosum, D. uncinatum* and *D. intortum* plots contained 8.0, 9.6, 11.4 and 11.7 per cent CP respectively.

TABLE X—TOTAL CRUDE PROTEIN PRODUCTION OF NATURAL GRASSLAND 16 MONTHS AFTER OVERSOWING WITH LEGUMES

Legume	Kg./ha. Crude Protein		Mean
	Kg/ha P_2O_5		
	0	105	
No legume	266*b**	325*b*	296
Stylosanthes gracilis	274*b*	423*b*	349
Trifolium semipilosum	316*b*	695*a*	506
Desmodium intortum	306*b*	749*a*	528
Desmodium uncinatum ..	270*b*	840*a*	555
Mean	286	606	—

S.E. of the mean $=54{\cdot}3$ kg.
Coeficient of Variation $=12{\cdot}2$ per cent.

*Means followed by the same letter do not differ signficantly at the 1 per cent probability level according to Duncan's multiple range test.

The results of this trial indicated that P was essential for quick establishment of tropical legumes oversown in unimproved grassland of Western Kenya. *D. intortum* and *D. uncinatum* were the most promising legumes in the improvement of these grasslands by oversowing.

Results from a current trial indicate that 50-60 kg per hectare P_2O_5 applied as single superphosphate is adequate for successful establishment of *D. uncinatum* by oversowing under Kitale conditions.

Seedbed pretreatments prior to oversowing D. uncinatum

C. gayana/*D. uncinatum* were oversown and topdressed with 500 kg per hectare single superphosphate.

Various seedbed treatments were prepared in the unimproved grassland prior to oversowing. The main-plot treatments were: untreated grassland, burned grassland, slashed grassland and grassland treated with paraquat. The sub-plot surface treatments were: untreated surface, raked surface, rotavated surface and surface with cultivated hoe strips.

The germination of *D. uncinatum* was delayed in the burned and slashed plots but this did not affect subsequent establishment. This delay was attributed to lack of protective cover for the oversown legume. The total DM yields (4 cuts) 15 months after oversowing are presented in Table XI.

TABLE XI—TOTAL DRY MATTER PRODUCTION OF NATURAL GRASSLAND 15 MONTHS AFTER OVERSOWING WITH *D. Uncinatum* AND *C. Gayana* (Kg/ha)

Main-plot treatments	Sub-Plot Treatments				
	Surface untreated	Surface raked	Surface +hoe strips	Surface rotavated	Mean
Grassland untreated	10,784	10,751	10,760	11,271	10,891
Grassland × paraquat ..	11,048	12,227	11,807	11,434	11,629
Grassland slashed	10,333	10,866	11,246	10,829	10,818
Grassland burned	11,372	12,167	9,865	11,715	11,280
Mean	10,884	11,503	10,919	11,312	—

S.E. of the mean for treatments = ±254 kg.
Coefficient of Variation = 3·3 per cent.

D. uncinatum contributed 50-70 per cent of the total DM in the final cut. *C. gayana* did not establish except in the rotavated plots and along the cultivated hoe strips.

Since there were no significant differences among the treatments, it was suggested that burning, grazing and leaving unimproved grassland untreated were the cheapest and quickest methods of seedbed preparation prior to oversowing *D. uncinatum*. *C. gayana* was to be included only when some form of cultivation was contemplated.

(b) Fertilizer Trials (N.C.O.K.)

A trial was established in 1967 to study the effects of four rates of fertilizer nitrogen and two rates of potassium on the dry matter yield of Napier grass (*Pennisetum purpureum*). The results of the 1970/1971 season follow a similar trend as was reported in the 1968 Annual Report. The full results will appear when the trial is terminated at the end of this season.

A detailed experiment whose objective was to determine the phosphate needs of a *Desmodium* based pasture over a three-year period is now in its fourth season and the necessity (or otherwise) of annual topdressing should be ascertained at the completion of the trial.

In an attempt to assess the soil fertility build up as a result of dung and urine returns under grazing, a trial was established in 1968. The treatments were: Setaria alone, Setaria with 500 kg/ha N (applied as A.S.N.) Setaria/*Desmodium uncinatum* and Setaria/ *D. intortum* compared under grazing and cutting regimes. The results of the 1970/1971 season follow a similar trend as was reported in the 1969 Annual Report.

(c) Undersowing (D.M.T.)

The effect of a maize cover crop on the establishment and subsequent production of a *Desmodium uncinatum*/Rhodes grass mixture and the influence of undersowing on maize grain yield is being studied in two factorial trials with four maize populations, two times of undersowing and with and without a nitrogen topdressing. Yields of maize from these trials have been reported previously. Herbage production from the first trial during the second production year is shown in Tables XII and XIII. The first experiment was established in 1968 and the second in 1969.

TABLE XII—1970/71 DRY MATTER (DM) YIELD OF *D. uncinatum* COMPONENT WHICH WAS ESTABLISHED UNDER MAIZE CROP IN 1968 AT DIFFERENT TIMES (KILOGRAMMES PER HECTARE)

TREATMENT	MAIZE POPULATIONS-PLANTS PER HECTARE				Mean
	0	18,500	3,700	55,500	
*T_1N_0	4,528	4,470	4,530	4,560	4,522
T_1N_1	3,725	4,131	3,882	4,019	3,939
**T_2N_0	4,081	4,639	4,362	4,426	4,377
T_2N_1	4,353	4,366	4,196	4,085	4,250
Mean	4,172	4,402	4,243	4,273	—

S.E. Table mean±726
S.E. Marginal means±583
C. of V. 17 per cent
*T_1 sown at the time with maize
**T_2 sown seven weeks later after maize has been weeded twice.

TABLE XIII—DRY MATTER YIELD OF RHODES GRASS/*Desmodium uncinatum* (ESTABLISHED IN 1968 UNDER MAIZE CROP) DURING THE SECOND PRODUCTION YEAR (1970/71) KG/HA.

TREATMENT	MAIZE POPULATIONS-PLANTS PER HECTARE				Mean
	0	18,500	37,000	55,500	
T_1N_0	8,683	9,037	9,901	10,713	9,584
T_1N_1	8,033	8,839	8,302	8,753	8,482
T_2N_0	8,929	9,373	9,797	9,602	9,425
T_2N_1	9,449	9,803	9,729	9,375	9,589

S.E. Single plot±1678
S.E. Difference Table means±1370
Marginal means 685
C. of V.

Table XIII shows the total yield of Rhodes grass/*Desmodium uncinatum* during the second production year (1970/71). Table XII shows yield of Desmodium component during the same year. It can be seen from these tables that the effect of maize populations, time of undersowing and fertilizer nitrogen (applied to the maize crop during the establishment year 1968/69) almost disappeared during 1970/71. Although there was a small decrease in yield due to fertilizer nitrogen, there were no significant differences between any two treatment means.

Table XIV shows the first production year (1970/71) yield of Mbarara Rhodes grass/*D. uncinatum* pasture from the second experiment in kilogrammes per hectare.

TABLE XIV—THE FIRST PRODUCTION YEAR (1970/71) DM YIELD OF MBARARA RHODES/*D. uncinatum* UNDERSOWN AT DIFFERENT TIMES AT DIFFERENT MAIZE POPULATIONS DURING ESTABLISHMENT YEAR (KG/HA)

TREATMENT	MAIZE POPULATIONS-PLANTS PER HECTARE				Mean
	0	18,500	37,000	55,500	
T_1N_0	8,798	7,852	8,129	9,006	8,446
T_1N_1	9,290	10,121	8,757	10,414	9,646
T_2N_0	8,794	7,755	8,095	8,004	8,162
T_2N_1	11,947	8,549	9,081	8,216	9,448
Mean	9,707	8,569	8,516	8,910	—

S.D. Single plot ±1007
S.E. Table means ±664
S.E. Marginal means ±332
C. of V. 11 per cent
L.S.D. 5 per cent Table means 1356
Marginal means 678

The total yield of grass and legumes were of the same order as those of the first experiment (Tables XII and XIII) but response of the pasture to nitrogen applied to maize crop was different. Nitrogen resulted in significantly higher DM yield than the treatments which received no fertilizer N. Time of undersowing had no significant effect of pasture establishment. Late undersown treatments, however, resulted in lower grass component yield than early undersown treatments. Grass established better when sown directly without cover crop.

TABLE XV—THE FIRST PRODUCTION YEAR (1970/71) YIELD OF *Desmodium uncinatum* COMPONENT WHEN GROWN IN ASSOCIATION WITH MBARARA RHODES GRASS—DRY MATTER IN KG/HA

TREATMENT	MAIZE POPULATIONS-PLANTS PER HECTARE				Mean
	0	18,500	37,000	55,500	
T_1N_0	3,102	3,795	3,260	3,853	3,503
T_1N_1	3,804	4,758	3,681	5,519	4,441
T_2N_0	2,712	3,376	3,880	3,266	3,309
T_2N_1	3,871	3,795	4,764	3,485	3,979
MEAN	3,373	3,931	3,896	4,031	—

L.S.D. 5 per cent Table means 1513
Marginal means 758
Coefficient of Variation 25 per cent

The first production year yields of Desmodium component were generally higher than those of the first experiment. Yield of the legume component tended to increase with increasing maize population. In this experiment nitrogen resulted in significantly higher yields of Desmodium component in early undersown treatments. Time of undersowing did not seem to affect Desmodium establishment.

(d) Grass variety trial (D.M.T.)

A grass variety trial was established in 1968 to compare productivity of nine main varieties when grown in association with *Desmodium uncinatum* or when fertilized with ammonium sulphate nitrate. The grass varieties compared are given in Table

XVI. In the establishment year N fertilizer was applied in two split applications at the rate of 400 kg N/ha/year. In subsequent years N fertilizer was topdressed in 5 equal applications at the rate of 500 kg N/ha/year. Single superphosphate was applied overall at seedbed at the rate of 500 kg/ha and in subsequent years it was applied at the rate of 250 kg/ha. Table XVI gives dry matter (DM) yields for the first and second production years in kilogrammes per hectare.

TABLE XVI—THE EFFECT OF FERTILIZER NITROGEN AND *D. uncinatum* ON DM YIELDS OF SEVERAL GRASS SPECIES (KG/HA)

1969/70

Variety	Nitrogen and Legume			Mean
	(1)	500 kg N/ha	*D. uncinatum*	
Mbarara Rhodes	6,175	17,371	6,707	10,084
Masaba Rhodes	5,414	18,570	5,967	9,983
Pokot Rhodes	5,857	17,204	6,634	9,898
Makueni Guinea	4,757	16,538	6,708	9,334
Embu Guinea	3,613	15,567	4,625	7,935
Coloured Guinea	3,739	14,053	5,454	7,749
Nandi I	2,846	14,800	4,095	7,247
Nandi II	3,094	13,612	4,737	7,148
Congo signal	3,668	11,937	5,364	6,989
Mean	4,351	15,517	5,588	—

S.E. Varietal means ±300 L.S.D. (P=0·05)=636 kg/ha.
S.E. N means ±308 L.S.D. (P=0·05)=623 kg/ha.
C of V.=18 per cent.

1970/71

Mbarara Rhodes	4,033	13,448	7,612	8,364
Masaba Rhodes	5,247	9,961	9,897	8,398
Pokot Rhodes	4,186	13,174	6,728	8,029
Makueni Guinea	4,808	12,516	6,445	7,923
Embu Guinea	3,620	11,769	5,953	7,114
Coloured Guinea	4,252	10,748	7,392	7,464
Nandi I	3,041	10,569	5,803	6,471
Nandi II	3,037	11,382	6,997	7,139
Congo Signal	3,813	11,160	7,435	7,469
	4,004	11,636	7,150	—

L.S.D. (P=0·05)=738 (varetal means)
L.S.D. (P=0·05)=707 (N means)
C. of V. =24 per cent

Establishment of all grass species was satisfactory but *D. uncinatum* was patchy in most plots. During the first production year (1969/70) Rhodes grasses and Makueni Guinea significantly yielded more than other species. Mbarara Rhodes and Masaba significantly outyielded Makueni Guinea (P=0.05). The lowest yields were obtained from the Congo signal and Nandi I and II. During the second production year the results follow a similar trend.

All grasses responded greatly to nitrogen fertilizer. Fertilizer treatment outyielded the control by over 3 times. The presence of *Desmodium uncinatum* increased dry matter production by more than 1,000 kg/ha in the first year and by more than 3,000 kg/ha in the second year.

(e) Fodder crops (D.M.T.)

(i) A trial which was established in 1966 to compare productivity of three grass/legume mixtures was concluded during 1970/71. The treatments were: Napier grass (*Pennisetum purpureum* cv. French Cameroons), Guinea Grass (*Panicum maximum* cv. Nchisi) and Guatemala Grass (*Tripsacum laxum*) with two legumes *Desmodium uncinatum* and *D. intortum*. The results in Table XVII refer to the dry matter yields for 1969/70 and 1970/71.

TABLE XVII—DRY MATTER YIELDS OF MIXTURES OF THREE FODDER GRASSES AND TWO LEGUMES (KG/HA)

1969/70

Grasses	CONTROL	LEGUMES		Mean
		D. uncinatum	*D. intortum*	
Napier	5,741	8,887	8,681	7,770
Panicum	4,085	7,638	9,438	7,054
Guatemala ..	6,954	9,327	9,818	8,700
Mean	5,593	8,617	9,312	

L.S.D. P=0·05 table means=1,200
L.S.D. P=0·05 marginal means =649

1970/71

Napier	4,879	13,560	13,840	10,760
Panicum	2,486	8,958	8,962	6,802
Guatemala ..	4,226	11,138	10,065	8,476
Mean	3,864	11,219	10,956	—

L.S.D. P=0·05 table means 2,134
L.S.D. P=0·05 marginal means 1,232

It will be seen from Table XVII that the presence of legumes resulted in higher dry matter yields. *D. intortum* was more vigorous during 1969/70 than *D. uncinatum* but during 1970/71 effects of the legume were of the same order. Yields of grasses were not significantly different in 1969/70 but during 1970/71 Napier grass outyielded the other grasses significantly. Guatemala grass also outyielded *Panicum maximum* significantly (P=0.05). Yields of grasses growing in absence of legumes dropped markedly.

(ii) A trial which was established in 1968 to investigate the effects of different spacings and intervals of cutting on herbage production of Musinya variety of sweet potatoes was completed early in 1970. Treatments and results are given in Tables XVIII and XIX.

TABLE XVIII—1968/69 DRY MATTER YIELDS IN (KG/HA)

Cutting interval in months	SPACING IN CM				Mean
	30×30	30×60	60×60	90×90	
2	7,295	7,911	6,935	5,028	6,792
3	9,377	9,542	9,076	6,890	8,721
4	8,893	9,361	7,288	7,269	8,203
6	8,713	8,203	7,807	5,426	7,537
Means	8,569	8,754	7,777	6,153	—

L.S.D. (P=0·05) (marginal means)= 909 kg/ha
L.S.D. (P=0·05) (table means) =1,813 kg/ha
C. of V. =3·9 per cent

TABLE XIX—1969/70 DRY MATTER IN KG/HA (SECOND SEASON HARVESTS)

Cutting Intervals in months	SPACING IN CM				Means
	30×30	30×60	60×60	90×90	
2	3,169	3,155	3,383	1,720	2,857
3	6,122	6,269	6,808	4,230	5,857
4	5,035	5,783	4,832	3,849	4,858
6	4,943	6,261	4,323	4,396	4,981
Mean	4,817	5,367	4,837	3,549	

L.S.D. (P=0·05) (marginal means) 194 kg/ha
L.S.D. (P=0·05) (table means) 386 kg/ha
C. of V=5 per cent

From Tables XVIII and XIX it is seen that the best spacing for Musinya variety of sweet potato was 30 cm. between plants and 60 cm. between rows. The best interval between cutting was between 3 and 4 months. Yields of the first production year (Table XVIII) were much higher than those of the second year (Table XIX). The yields were generally low probably because no fertilizers were used.

(iv) ANIMAL PRODUCTION—(J. F. Odhiambo)

Investigations were carried out on the effect of stage of growth of elephant grass, *Pennisetum purpureum*, on its nutritive value. Three stages of regrowth were considered each time. These were eight, ten and twelve weeks in the dry season of 1969, and, seven, nine, and eleven weeks in the wet season of 1970.

The fields were pre-trimmed and established over a period of eleven and ten weeks in the dry season and wet season respectively. After trimming the fields were top-dressed with Ammonium Sulphate Nitrate (26 per cent N) at the rate of 224 kg per hectare. At feeding time, the feed were manually cut from the field at an approximate height of 15 cm. above the ground. The feed was then hand-chopped into short lengths of five to ten centimetres, and then uniformly mixed before feeding in boxes to individually housed young Jersey cattle between the ages of five to six months in the dry season and six to twelve months in the wet season. Initial average liveweights in the three treatments were 70.8, 69.5 and 72.2 kg for dry season and 101.7, 100.8 and 111.7 kg in the wet season.

TABLE XX—FEED CONSUMED IN KILOGRAM DRY MATTER BY YOUNG GROWING CATTLE BEING FED *ad libitum* ON ELEPHANT GRASS (*Pennisetum purpureum*) OVER AN EIGHT WEEK PERIOD

Season	Treatment	Age at Cutting (Weeks)	Height at Cutting CM (Inches)	No. of Animals	Total Feed Consumed kg**	Std Error of Diff. Between Means*	Coeff. of Variation Percentage	Percentage CP.	Percentage CF.
Dry 1969 ..	1	8	76·2(30)	6	993·9	(1·2)±8·2	12·47	11·58	30·07
	2	10	91·4(36)	6	1,131·7	(1·3)±7·2	12·21	10·38	31·00
	3	12	106·7(42)	6	1,068·0	(2·3)±7·7	10·00	9·87	31·41
Wet 1970 ..	1	7	91·5(36)	6	1,212·5	(1·2)±9·6	10·63	10·74	30·59
	2	9	122·0(48)	6	1,198·7	(1·3)±8·4	14·61	10·79	30·68
	3	11	137·0(54)	6	1,250·1	(2·3)±9·9	11·22	10·03	31·00

**Differences in dry matter consumption between treatments were statistically non-significant.

*Figures in brackets refer to treatments.

Feed consumed was found by difference between feed offered and feed left over each of which was also sampled for laboratory analysis of the dry matter, crude protein and crude fibre contents. Liveweight increase was found by difference between liveweight at the time of entering the experiment and liveweight eight weeks later at leaving the experiment.

The results which are given in Tables XX and XXI show that there were no important differences in either the feed dry matter consumed or the liveweight increases between the three treatments. The laboratory figures for percentage crude protein were also very similar in the three treatments for both the dry season and the wet season.

The results would show that elephant grass does not alter significantly in nutritive value between the stages of regrowth considered. Within this range of stages of regrowth, the important factor to determine the time of utilization will be the dry matter yield per unit area per year.

TABLE XXI—LIVEWEIGHT INCREASE (AVERAGE PER ANIMAL) OVER THE EIGHT WEEKS OF EXPERIMENTAL FEEDING OF ELEPHANT GRASS (*Pennisetum Purpureum*) TO YOUNG GROWING CATTLE

Season	Treatment	Number of animals	L. WT gain per animal kg**	Std. error of diff. between means	Coeff. of of variation per cent
Dry 1969	1	6	42·0	(1·2)±5·4	28·12
	2	6	50·4	(1·3)±6·5	11·67
	3	6	43·0	(2·3)±5·0	25·23
Wet 1970	1	5*	60·4	(1·2)±9·8	29·78
	2	6	52·3	(1·3)±9·9	26·53
	3	6	52·0	(2·3)±8·1	27·01

*One animal was incapacitated in the course of trial.

**The differences in mean liveweight gain between treatment were statistically non-significant.

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PLANT BREEDING STATION, NJORO

A.—Review of the Year

A good wheat crop of nearly 2 million bags (Table I) was harvested in 1970 despite the reduction of land planted to 128,060 hectares, as compared to 164,552 hectares in 1969. The reduced planting was mainly due to discouragement of wheat growing in marginal and sub-economic areas, and to a lesser extent, to changes in farm ownership and farming patterns. The average yield of 15.1 bags per hectare was an improvement over the 14.5 bags per hectare in 1969, but still not equal to the record yield of 17.6 bags per hectare in 1967.

TABLE I—WHEAT PRODUCTION BY DISTRICTS, 1969–1970

District	Hectares 1970	Per cent of Total	AVERAGE YIELD (BAGS/HECTARES)		TOTAL PRODUCTION (BAGS OF 90 KILOS)	
			1969	1970	1960	1970
Uasin Gishu ..	48,622	38·0	14·6	13·1	858,425	639,175
Nakuru	36,564	28·6	16.3	19·3	722,556	707,824
Nyandarua ..	10,869	8·5	9·6	12·1	209,985	132,606
Kiene	9,457	7·4	9·6	8·1	130,318	76,318
Timau/Meru ..	6,985	5·4	26·7	24·4	169,815	171,320
Trans Nzoia ..	6,462	5·0	20·3	16·3	119,037	105,889
Narok	5,749	4.5	14·6	16·0	126,761	92,823
Laikipia	3,353	2·6	10·6	11·6	57,778	39,283
National ..	128,060	—	14·5	15·1	2,394,675	1,965,238

Weather conditions were generally favourable for wheat production although the rainfall pattern at Njoro (Table II) and in other areas was unusual. January was very wet and the long rains started early in March and continued through April and May. These heavy rains interfered with land preparation in some areas. Also, wet conditions in August delayed harvest and caused some crop damage, particularly in the Uasin Gishu District. In the Nakuru District, drying of wheat to reduce the high moisture content was generally necessary. In contrast to the abundant moisture during the main growing season and the high total rainfall, December was very dry and second crops sown in the Timau and Nyeri Districts suffered from lack of moisture.

TABLE II—RAINFALL AT NJORO

MONTH	Rainfall 40 years average 1930/1969	(MILLIMETRES)	
		1969	1970
January	25·5	72·2	136·3
February	36·3	69·9	14·0
March	67·6	98·5	130·5
April	125·3	44·9	181·9
May	115·1	150·0	154·9
June	80·9	24·7	64·6
July	108·1	58·0	76·2
August	115·8	60·3	127·4
September	62·9	107·6	67·7
October	54·0	45·3	59·6
November	80·3	52·6	108·9
December	50·2	16·0	24·8
TOTAL	922·0	800·0	1,146·8

Stem rust developed later than usual and caused little damage except in highly susceptible varieties. Ear rust caused severe damage at Timau and Molo in several varieties including Trophy. For the second year, the virus-like wheat yellows disease increased in prevalence. Early sown barley crops suffered from barley bulb fly damage and nitrogen deficiency, particularly in the Njoro area.

Staff changes included the appointment of a new counterpart Plant Pathologist and a Plant Breeder. Two Plant Breeders resigned, however, and were not replaced. Canadian Aid personnel were increased to five:— the Senior Wheat Research Officer, two Plant Breeders, a Plant Pathologist and an Agronomist. In addition a senior Cereal Chemist from Canada spent six months at the station advising on the expanded quality programme. The agronomist appointed under an FAO/Denmark project continued the cultivation programme started in 1969. Two Plant Breeders were away on training courses for most of the year, one on Ph.D studies in Canada and the other on a CIMMYT training course in Mexico.

Financial support for the station from the Wheat Board and the Ministry had to be increased because the grants from the Rockefeller Foundation and the British Ministry of Overseas Development were not renewed.

A Wheat Seminar for extension staff held in January was well attended. Wheat Recognition and Grading Courses held on two successive weeks in July had a record total attendance of 52. Wheat handlers and graders from seven different agencies including milling firms in Mombasa, Tanzania and Uganda showed great interest in these courses. An article entitled "Seventy Years with Wheat in Kenya" written by two former staff members was published as a special issue of East African Agricultural and Forestry Journal.

B.—Report on Experiments

ESTABLISHED WHEAT VARIETIES

Africa Mayo and Trophy were again the most widely grown of the seven fully recommended varieties. Trophy had more rust infection than usual and proved susceptible to two new races of stem rust. These races are not likely to increase sufficiently in 1971 to cause significant damage. Trophy also showed increased susceptibility to ear rust and was severely damaged in the high altitude areas, where it will no longer be recommended. The other recommended varieties gave generally good results when grown in suitable areas.

Kenya Leopard and several other varieties with restricted recommendation yielded better than usual because stem rust infection was late and caused little damage. The varieties Bonny, Fanfare and Kenya Plume were restricted in acreage because of poor quality.

The durum varieties Kenya Tai and Kenya Kasuku, grown under contract for semolina production, gave variable results. In many cases the quality was poor because of a high percentage of chalky kernels. The biscuit wheat Bounty gave good yields in the high altitude areas.

NEW RELEASES AND PEDIGREE CROPS

One new bread wheat named Twiga was released in 1970. This variety has good stem and leaf rust resistance, quality and straw strength and yields well in suitable areas. However, it does not have a wide range of adaptation and is being grown mainly in the Uasin Gishu area. It is susceptible to stripe or ear rust and should not be grown in the high altitude areas.

Two Pedigree Crops will be released as varieties in 1971. The extremely popular line PA/69 was held over from 1969 pending further quality tests. It met the quality standards in 1970 and has been named Kenya Kanga. This is an early, strong strawed, stem rust resistant variety which appears best adapted to medium and high altitudes. The other variety to be released, Kenya Bongo, is disease resistant, strong strawed and late maturing. It is best suited to the high altitude areas.

CROP AND VARIETY TRIALS

Wheat Variety Trial I consisting 31 established varieties, Foundation and Mother Crops was grown at 13 locations representing all the major altitudes and soil types of the wheat growing areas of Kenya. The durum variety trial was grown at five locations. Other wheat trials of material in an earlier stage of development were grown mainly at Njoro, Molo and Eldoret. Growth and yields were good in most of the trials. Four off-station trials were lost because of damage from birds, antelopes, hares or cattle. The yield trials at Londiani were extensively damaged by excessive moisture.

The barley variety trial was grown at five locations. It consisted of three two-rowed varieties, 19 six-rowed varieties and the presently recommended varieties, Proctor, Research and Zephyr. This programme of screening and release of improved barley varieties for malting and feed is needed because the presently grown varieties are not sufficiently disease resistant. Considerable interest is being shown in 6-row barley as a feed grain in Kenya.

The oat variety trial consisting of 12 varieties and introduced lines was grown at Njoro and Molo. Oats are grown on small acreages in Kenya for forage, feed and porridge purposes and there is a need for improved varieties with stem rust resistance.

Flax (20 varieties) and rapeseed (10 varieties) were grown at three locations. These crops grew well and produced good yields. It should be possible to produce rapeseed oil locally to help replace the large quantity of edible oils now imported.

INTERNATIONAL NURSERIES

(A. M. Patel)

A large amount of small grain cereal material originating in many countries was again received and evaluated for use in Kenya. These introductions included the following nurseries: —

International Spring Wheat Stem Rust Nursery

International Spring Wheat Stripe Rust Nursery

International Oat Rust Nursery

International Barley Disease Nursery

International Screening Nursery (Wheat)

FAO Near East Uniform Wheat Nursery

FAO Near East Uniform Barley Nursery

Yellow Rust Trial (Wheat and Barley)

1969 Introductions to the World Small Grain Cereal Collection (wheat, barley, oats and ryes).

At Njoro, 1,800 small grain cereal varieties were tested (approximately 1,400 wheat; 150 barley; 124 oats; 44 rye and 15 triticales). Out of these, 42 bread wheats, 24 durums and 20 barleys were sent to the Plant Breeding Section for the out of season multiplication and Preliminary Yield Trials in 1971. Those retained for further screening in 1971 were 121 wheat, 62 barley and 24 oats; and 216 varieties were entered in Parental Collection. All other varieties of oats were very susceptible to stem rust and were discarded.

At Molo, 1,388 wheat; 501 barley; 179 oats; and 62 triticale varieties were grown under high altitude conditions. Out of these, 22 wheat varieties were sent to Plant Breeding Section for Preliminary Trials in 1971. Seventy varieties were retained for further screening and 42 varieties were entered in Parental Collection. Also 190 lines from interspecific and intergeneric crosses were screened and 137 were retained for further screening and selection.

PLANT BREEDING AND GENETICS

Disease resistance, high yield and good quality continue to be the main objectives in the wheat breeding programme. Rust resistance has to be of first importance but increased yield has a very high priority. In recent years increased emphasis has also been placed on quality, especially in relation to export of wheat and flour. There is no incompatability between any of these desirable characteristics in wheat, and the aim of the plant breeders is to combine them to highest possible degree.

Problems arise regarding disposal of wheat lines which are exceptionally good in one characteristic but do not meet the minimum standards for the others. For example, one of the highest yielding lines in 1970 could not be released to Elite growers for multiplication because it was well below the present standard set for quality. However, its yielding ability will be fully utilized in crosses with other good lines and varieties. In this case, it is fortunate that there are several high yielding sister lines which appear to have better quality and might be considered for releases as new varieties in the near future.

Material in various stages of development gave encouraging results in 1970. Many of the lines developed at Njoro were much superior to the introduced varieties in the yield trials. Several of the 90 early maturing lines tested at Njoro and Rongai appeared very promising as early maturing (less than 120 days) varieties for lower altitudes. Promising material for the higher altitudes was found among the numerous lines tested at Molo. Some of the 44 semi-dwarf lines tested at Njoro were also promising. Many of the 88 Tobari 66 backcross lines showed good rust and blotch resistance and straw strength. Many of the numerous Romany backcross lines and intercrosses between Romany backcrosses appeared promising in rust resistance and agronomic type but others were very susceptible to blotch.

Progress was made in genetic studies aimed at identifying and isolating single genes for stem rust resistance in several varieties presently available in the breeding programme.

A study was started on the nature and inheritance of adult plant resistance to stem rust in wheat. This type of resistance is shown in some varieties which are susceptible to one or more races of rust in the seedling stage but later become resistant to the same race or races. It can be very important as shown by the varieties Africa Mayo and Kenya Page which exhibit adult plant resistance and have been grown commercially for 11 and 8 years, respectively, as compared to the average life of wheat varieties in Kenya of 4.4 years. The adult and seedling resistance of selected varieties and progenies of crosses and backcrosses to two races of stem rust is being studied in the greenhouse. Results should be available next year which will show the manner of inheritance of adult plant resistance and will indicate whether this valuable form of inheritance can be used on a more efficient and systematic basis in the Kenya wheat breeding programme.

PLANT PATHOLOGY

(D. E. Harder)

Wheat stem rust surveys were made in all of the wheat growing areas of Kenya, and in Tanzania and Ethiopia. Similar races were found in all of these regions, suggesting the exchange of, or a similar source of rust inoculum in these areas. Spore traps located at Njoro and Kitale in Kenya, and at Njombe in Tanzania showed that air-borne rust spores are present throughout the year. This is probably due to the wide variations in the cropping season in East Africa.

Six new races of stem rust were identified in 1970 by using new differential varieties of wheat. Two of these races attack the widely grown variety Trophy, which was previously resistant to stem rust. Most of the new races occurred infrequently and two of them were found only in Tanzania. Adequate sources of varietial resistance to these

races are available. Of the older races, E.A.5 still predominated among the collections but decreased from 66 per cent of the isolates in 1968 to 35 per cent in 1970. This is probably due to the banning in 1970 of the variety Romany, which was formerly widely grown and is susceptible to race E.A.5.

Leaf rust was very prevalent on susceptible varieties. Race identification studies were continued in the greenhouse. Only two races of major importance have been found to date.

Stripe rust occurred commonly and the ear rust phase caused severe damage to several varieties, including Trophy, at the higher altitudes. Ear rust was also found at Njoro. Work was started on the identification of races of stripe rust, which have not been previously studied in Kenya. One of the greenhouses was modified to try to supply the exacting temperature and moisture requirements for this rust.

The yellows disease reported previously was found in wheat and other cereals in several areas and caused considerable damage in some fields. Studies at the National Agricultural Laboratories suggest that this virus—like disease may be caused by a mycoplasma. Leafhopper transmission is suspected.

AGRONOMY

I.—Cultivation Trials—K. K. Poulsen

The first full year of operation was completed on the cultivation trials started after harvest in 1969 at six sites chosen to represent the major wheat growing areas in Kenya. As described in the 1969 report, the traditional method of ploughing, following burning of the straw, was compared with surface cultivation methods in five different treatments.

There were no significant differences in yield at any of the sites, probably because ample soil moisture was available throughout the season. Differences in yield between the treatments are more likely to show up in years of normal or low rainfall.

At one trial site near Njoro, the land was almost 100 per cent covered by Kikuyu grass (*Pennisetum clandestinum*) in late 1969. During 1970, the surface cultivation methods gave far better control of this grass (reduced to 5 per cent cover) than the traditional ploughing methods (55-61 per cent cover).

The costs of the different treatments require further study. Experience so far indicates that three surface cultivations can be done in the same time as one ploughing. This indicates that surface cultivation will reduce the costs of land preparation from 25-75 per cent in most areas.

II.—Fertilizer Trials—H. A. Mulamula

In the 70 fertilizer trials successfully completed in 1970, phosphate again proved to be the most important plant nutrient required. However, there was a marked increase in the number of sites that showed response to nitrogen alone or with phosphate, probably because of the wet season. There was also an unusually good response to the higher nitrogen levels of 40, 60 and 80 Kg per hectare.

No new information emerged from the 1970 copper trials. Seed dressing followed by foliar spray with copper oxychloride is still the only effective and the cheapest method of overcoming copper deficiency. Rates of application still remain 1 Kg/h of copper oxychloride as seed-dressing followed by 1 Kg/h copper oxychloride as a foliar spray. Enhanced phosphate response in the presence of copper in deficient areas was again observed for the third year.

III.—Herbicide Trials—P. K. Ronoh

Herbicide trials were conducted in the low, medium and high altitude areas. Esters tended to depress yields at low altitudes although weed control was good. Their performance was improved with increase in altitude. On the other hand, the two other types of herbicides such as M.C.P.A. tended to control weeds less effectively at the higher altitude. C.M.P.P., unlike the other herbicides tested proved to be versatile at all altitudes. It controlled even the more resistant weeds such as cleavers and had the least depressing effect on yield.

Late application of herbicide (over 6 weeks after planting) not only failed to control weeds but also had a depressing effect on yield.

QUALITY TESTS

Quality tests on wheat varieties and lines were continued in the temporary laboratory at Njoro and in co-operation with Chief Chemist, Unga Limited in Nairobi. Special attention was given to the Pedigree Crop PA/69 (FW/68) which did not meet the quality standards in 1969 and was held over for another year. Samples of PA/69, Africa Mayo and Trophy grown on the same ten farms in representative areas were tested for baking quality and other characteristics. As a result, PA/69 was approved by the Quality Committee of the Wheat Board and was released as the variety Kenya Kanga in 1971.

New equipment obtained for quality testing was put into operation at Njoro under the guidance of a Senior Cereal Chemist from Canada. He also prepared detailed specifications for the new Quality Laboratory now under construction, and recommended additional equipment, especially for milling and baking. With these new facilities it will be possible to assess wheat lines for quality at a much earlier stage in the breeding programme than in the past. It will be desirable, however to continue collaboration with Unga Limited in the final stages of quality evaluation.

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PYRETHRUM RESEARCH STATION—MOLO

A.—Weather

The monthly rainfall and mean temperatures for 1970 of the main station and four research sub-stations in Kenya are given in Tables 1 and 2 respectively. No records were made at Keroka for the first half of 1970 and none at all for Limuru substation.

TABLE I—MONTHLY RAINFALL (mm). OF MOLO AND RESEARCH SUB-STATIONS

Months	Molo	Marindas	Subukia	Ol Joro Orok	Keroka
January	186·9	77·5	185·1	100·9	—
February	31·7	14·2	0·0	1·0	—
March	148·8	38·1	82·5	69·4	—
April	207·6	25·9	206·8	104·4	—
May	121·0	165·4	175·4	79·4	—
June	163·8	4·6	53·0	124·8	—
July	120·5	114·3	51·5	91·1	17·8
August	210·1	114·3	138·7	148·1	174·7
September	60·6	94·7	101·1	87·3	85·1
October	31·2	5·6	88·9	35·0	90·1
November	67·7	54·7	28·7	17·0	90·4
December	11·9	12·9	34·1	7·3	80·0
TOTAL	1,361·8	672·2	1,145·8	865·7	—

TABLE 2—MEAN MONTHLY TEMPERATURE (°C) OF PYRETHRUM RESEARCH STATIONS

Months	Molo	Marindas	Subukia	Ol Joro Joro Orok	Keroka
January	14·3	14·6	15·3	14·0	—
February	14·2	15·1	15·7	14·4	—
March	14·9	14·8	16·1	15·1	
April	14·4	15·3	14·7	14·6	—
May	14·2	15·3	14·4	14·2	—
June	13·3	13·8	14·0	13·0	—
July	12·8	12·9	14·0	12·2	13·5
August	12·8	12·9	12·2	11·9	13·2
September	14·5	14·3	13·3	11·9	13·8
October	13·9	14·7	13·3	12·2	14·0
November	13·1	14·4	14·5	13·1	14·6
December	13·6	15·3	15·0	12·2	14·9

In general, most pyrethrum growing areas experienced rather wet conditions during the first eight months of the year, followed by four months of dry conditions.

B.—Flower Production

The production was notably low in the first eight months of the year despite good rainfall. This fall in production could be attributed to splitting commercial fields into new ones on a scale larger than normal, following an extensive campaign by the Pyrethrum Marketing Board. However, from September onwards the production increased fast, especially in the Kisii area. The total flower production for the 1970/71 pool year was 6,700 tonnes which was below the world market demand of over 10,000 tonnes.

C.—Experimental Work

Survey of Growing Areas

It was thought necessary to survey the growing areas with respect to the standard of agronomy and the plant material used. The areas visited were: Limuru, South Kinangop, Mt. Kipipiri in North Kinangop, Dundori, Molo region, Mau Narok region and Kisii district. Apart from Kisii all other areas border the Rift Valley.

The Rift Valley areas, although ranging from 2,000m to 2,900m had one characteristic in common, the plant material being often semi-blind, i.e. poor flowering and yielding. Nearly all fields consisting of local, unknown, material contained a smaller or larger proportion of these unwanted semi-blind plants. Fields planted with one clone (mono-clonal fields) did not show this characteristic. Nearly all such mono-clonal fields were of recognized clones, 1709, 4331 or Feingold clones, with clone 1708 occurring most frequently. In Kisii these semi-blind plants did not occur. This difference is most likely due to the fact that cutting back just before the Long Rains started is widely accepted in the Rift Valley areas but not at all in Kisii. When a field is used for resplitting to plant new fields it is very difficult to discern the good plants from the poor ones in case of cutting back. The semi-blind plants in fact look much healthier with all their leaves, give more splits and establish better, due to their vegetative condition. In this way a selection for more vegetative, semi-blind plants is bound to occur. On the contrary, in Kisii the well-flowering plants tend to be selected at splitting as no cutting back was practised. Non-flowering plants are easily recognized and not taken. It is therefore recommended not to cut back the fields planned for resplitting.

When all farmers in the Rift Valley areas could be induced to remove the semi-blind plants from their fields and to gap up with well-flowering material from the same fields a yield increase of 30 to 50 per cent could be expected.

Picking was as a whole done fairly well. In some cases the overblown flowers were left as they were thought to reduce the quality of the flowers. It should be realized that overblown flowers in general have a higher content than the "just opened" flowers. Leaving such overblown flowers on the plants means a reduction in pyrethrins yield. At the same time the initiation of new flowers may be reduced as the overblown flowers proceed to seed setting, which demands a considerable amount of energy.

Weeding still forms a problem. Although most fields were kept more or less clean of weeds, weeding was often done so roughly that the pyrethrum plants were damaged to some extent.

In the Rift Valley areas it was just quite clear that the pyrethrum plants become taller, more vigorous and healthier (apart from bud disease) at the higher altitudes. This was most conspicuous at altitudes above 2,700m. Bud disease increased in frequency with higher altitudes. In Kisii (1,800m to 2,200m) it was nearly absent, at Mt. Kipipiri, at 2,900m. It was abundantly present.

As far as the spreading of recognized, superior clones, the situation was quite encouraging. The situation was by far the best around Molo, due to the presence of the Pyrethrum Research Station. Clones 1708 and 4331 are at present very frequently met, and fields as large as 50 acres with either one are now in production. In the other areas of the Rift Valley 1708 occurs most frequently, due to its much earlier introduction. Clones 4331 and to a lesser extent Ma/63/1889 and Ma/62/93 can be met. The results of these clones are in very good agreement with the results obtained in formal trials.

In Kisii the introduction of recognized clones has not progressed so far for several reasons. The local material is far better than in the Rift Valley, which diminishes the need for better material. As it is in an area quite different from the Rift Valley most clones recommended for the Rift Valley are not suitable for Kisii, leaving only very few possibilities.

Root Knot Nematodes

The clonal selection programme aims at superior clones, tolerant to root knot nematodes. The seedlings from which the initial selection is done, have to be infected from the very beginning. This can be accomplished by growing infected pyrethrum splits on the seed beds in the period April to September. The seeds are sown in October in soil heavily infested with root knot nematodes and nearly all seedlings become infected as already reported in the Annual Report of the Senior Pyrethrum Officer, 1969.

To test another method two flats (each 0.70 x 1.50 x 0.15 m) were filled with forest soil. Roots of heavily infected plants were, finely cut, worked into the soil of one flat. Seeds of variety P4 were sown ca 3 weeks later. From the beginning the seedlings in the −N flat (no nematodes) grew better than those in the +N flat (nematodes worked in). Four months after sowing the seedlings of both treatments were compared. The −N seedlings had a fresh and dry weight 50 per cent higher than the +N seedlings. All +N seedlings had indeed a considerable number of root knots, the −N seedlings had none. This method is apparently a very effective one. At the same time it confirms the other findings that the root knot nematode hampers growth very considerably.

Spacing and Plant Population

In the 1969 Annual Report of the station the preliminary results of two trials were given. Table 3 and 4 give the final results. Table 1 shows, that in the first season, the closer spacing was the best one. This was a wet season. The second season was dry and here the wider spacing was slightly better probably because at a wider spacing water competition becomes less severe in dry years. Comparing the same number of plants at

Table 3—Relative Flower Yields in Two Seasons at Two Spacings of Two Trials

Spacing (cm)	Fresh Flower Yield	
	1st Season	2nd Season
60 x 30	100	100
60 x 45	88	104
60 x 30	100	100
60 x 60	81	102

two spacings (Table 2) then it is clear that a row distance of less than 60 cm (2′) is not to be advised as the yields were reduced with 23 per cent when planted 45 cm (1½′) apart. This may be due to damage to the plants when weeding.

Table 4—Relative Flower Yields in Two Seasons at Two Spacings and Two Plant Desnities

Number of plants per acre	Spacing (cm)	Fresh Flower Yield	
		1st Season	2nd Season
21,000	60 x 30	100	100
	45 x 40	78	96
28,000	60 x 22·5	100	100
	45 x 30	80	73

Pyrethrum content in relation to stage of flowering

On average the pyrethrins content of the pyrethrum flowers increases from opening until a maximum is reached a few days before overblown (all florets open). Studying the individual clones marked differences in this respect were found. Table 5 gives the results of 5 clones of which 4331 was nearest to the average. The maximum of 4394 was already reached just after opening, while Ma/63/1889 reached it not before overblown.

TABLE 5—PYRETHRINS CONTENT OF 5 CLONES AT 5 STAGES OF FLOWERING

Stage of flowering	PYRETHRINS CONTENTS OF CLONE				
	4394	Ma/63 1889	4331	KS/63/11	Ma/65/99
Ray florets vertical ..	1·05	1·37	1·44	1·75	2·20
2 to 3 rows of florets open ..	1·05	1·46	1·54	1·90	2·43
4 to 6 rows of florets open ..	1·00	1·52	1·61	1·90	2·59
Nearly all florets open ..	0·95	1·58	1·60	1·92	2·69
2 to 3 days after the last floret opened	0·88	1·61	1·51	1·90	2·70

RAISING SEEDLINGS

The usual procedure is to sow seeds in open furrows 1 to 2 cm deep at a density of about 5 seeds per cm row. After sowing the beds are mulched with grass. After germination the mulch is removed and replaced by a shade of grass some 30 to 80 cm above the beds. This shade, gradually thinned out, is removed after 3 to 4 weeks.

A few trials had already shown that the shade is not essential provided the soil is kept reasonably wet. The non-shaded seedlings grew faster and seemed stronger.

The effects of shade versus no shade was studied in one experiment. One month after sowing (about 20 days after emergence) the fresh and dry weights of the shoots and roots of the seedlings were determined as well as their length (Table 6). The seedlings without shade developed a much better and deeper root system and grew faster too. The experiment is continued to measure the growth over the full 5 to 6 months of growing period.

TABLE 6—SHOOT AND ROOT DRY WEIGHTS, SHOOT/ROOT RATIOS AND LENGTH OF 100 SEEDLINGS GROWN WITH OR WITHOUT SHADE

	DRY WEIGHT (mg)		SHOOT/ROOT RATIO		LENGHT (cm)	
	Shoots	Roots	Fresh	Dry	Shoots	Roots
Shade	122	13	7·5	9·4	3·2	2·6
No Shade	362	158	2·0	2·3	2·6	6·4

Drying of flowers

Flowers are still often dried outside in the sun. This may be a slow process when sunshine is lacking. Trials were carried out to find the effect of slow drying on the total pyrethrins in the flowers. When dried extremely slowly the flowers became very mouldy. These moulds resulted in a strong decrease of dry matter through respiration

and in a considerable decrease in pyrethrins. However, such slow drying does not seem to occur under practical condition. In another trial drying was slow but just rapid enough to prevent moulds moving in. Two hundred and fifty grammes of fresh flowers were dried in 5 ways, the number of hours to fully wilted (dead), the amount of dry matter and of pyrethrins content were determined. The results are given in Table 7. The slower the drying, the higher the loss of dry matter due to respiration before wilting. This, however did not affect the amount of pyrethrins at all. The loss of dry matter resulted in an increase of the content. When it is supposed that no pyrethrins are synthesized during the period before wilting the impression is gained that some pyrethrins are lost at the fast drying. The conclusion, to be drawn from this is that drying outside in the sun even if there is only a few hours of sunshine per day is a very good method. It, in fact, tends to increase the pyrethrins content, favourable for the extraction in the factory.

TABLE 7—TIME TO WILTING, RELATIVE DRY MATTER WEIGHT, PYRETHRINS CONTENT AND MG OF PYRETHRINS ON 250g OF FRESH FLOWERS AVERAGE OF 5 REPLICATES

Method of drying	Wilted in hours	Relative dry matter weight	Pyrethrins content	mg pyrethrins
1. Oven, 80°C for 2 hours then 45°C until dry	2	100·0	1·72	1,150
2. Green house, white washed ..	70	94·1	1·91	1,233
3. Outside in sun during day ..	60	96·0	1·91	1,245
4. Outside in shade	120	93·5	1·95	1,233
5. Inside, room temperature ..	145	91·0	1·92	1,190

Correction in yield trials for missing plants

Often a number of splits do not establish in yield trials. This, of course, tends to underestimate the yield. In the clonal selection programme this is not a major problem as the selection should aim at clones, which establish very well.

"In other trials, like fertilizer trials, it is of importance to be able to correct for such missing plants." A very good method in case of a replicated yield trial is the application of the analysis of covariance. However, to have an idea what kind of correction should be applied a trial was planted in April 1968. Two clones, Ma/63/1890, representing a low yielding clone and 4331 representing a vigorous, high yielding clone, were planted in 5x replicates, each having seven treatments. After planting and establishment drop-outs were filled. These were very few. In one treatment all plants were kept. In the other 6 treatments the proportion of plants removed to imitate drop-outs were 16 per cent, 33 per cent and 50 per cent per two treatments each. The plants within each couple of treatments were removed either singly or in groups of five. Table 8 shows the flower yields for each of the treatments in the first and in the second season. The results of the two clones were pooled as they behaved very similar to each other. With the plants removed singly the corrections needed are small. In the first season a correction of 10 to 20 per cent could be applied when 30 to 50 per cent of the plants drop out at random. In the second year no correction is needed. However, drop-outs often tend to be clustered and in that case larger corrections are required. In the first season a correction of about $\frac{2}{3}$ of the percentage of missing plants fits. In the second year the correction needed is only about half of that in the first year ($\frac{1}{3}$ of the percentage of missing plants).

TABLE 8—FRESH FLOWER YIELDS IN RELATION TO PATTERN OF PLANTS, DROPPED (TAKEN) OUT. THE YIELD OF THE CONTROL TREATMENT WAS SET AT 100 PER CENT IN EACH YEAR

Proportion of plants removed	PLANTS REMOVED IN GROUPS OF			
	ONE		FIVE	
	1st Season	2nd Season	1st Season	2nd Season
0 per cent ..	100	100	100	100
17 per cent ..	103	105	88	97
33 per cent ..	89	95	79	81
50 per cent ..	81	100	64	83

BREEDING

Selection criteria

Correlations between selection criteria may hamper the selection. Some investigations have been carried out to see whether some of the criteria vary in relation with others. Although no definite proof has been obtained there seems to be a negative relations between flower yield and pyrethrins content at contents of over 1.60 per cent.

Flower size is clearly correlated with dry matter content of the flowers (Table 9), but not with flower yields and pyrethrins content.

TABLE 9—DRY MATTER CONTENT AND FLOWER SIZE OF 100 GENOTYPES DERIVED FROM M42. THE GENOTYPE ARE GROUPED ACCORDING TO THE FLOWER SIZE INTO 6 GROUPS.

Average 100 flower weight in g.	*Dry matter per cent*	*Pyrethrins content per cent*
47	24·0	1·58
52	23·8	1·52
56	23·5	1·62
62	23·2	1·53
67	23·1	1·54
78	22·6	1·58

To obtain an impression of the variation between clones in Kenya for the different selection criteria a number of clones with their genetic values are given in Table 10. The variation is considerable for most traits, only moderate for "time to overblown" and decidedly small for "dry matter content of the flowers".

Variation in the ratio between Pyrethrins I and Pyrethrins II

The genetic variation in single and polycrosses were described in the 1969 Annual Report. Flower size and pyrethrins content were studied. Another characteristic with a high heritability is the ratio between the Pyrethrins I and Pyrethrins II fractions. About 100 plants of K.73 were sampled and studied for their PyI/PyII ratios. The parents have a ratio of 0.8 (clone 3093) and 1.1. (clone 4026) respectively. The seedlings of the single cross between these two clones varied between 0.4 and 2.4. The wide transgression over the parent values again confirms the heterozygous condition of pyrethrum clones.

Table 10—Genetic Value of 14 Clones for 7 Traits. The Extremes are Underlined

Clone	Relative flower yield	Pyrethrins content per cent	Fresh Weight of 100 Flower (g)	Dry Matter content Per Cent	Lodging +	Days from opening of the flowers to just overblown	PyI/pyII ratio
4331	100	1·60	62	22·1	4	16	2·5
SB/65/58.. ..	75	1·70	78	22·7	4	—	1·9
Ma/62/246 ..	70	1·80	84	22·7	4	18	1·3
4098	70	1·65	66	22·7	2	17	1·1
4729	60	1·66	79	22·8	5	22	0·9
1708	60	1·63	64	22·5	4	16	0·6
1171	60	1·37	95	22·7	—	—	0·8
Ma/65/99 ..	40	2·55	60	—	4	19	—
0/66/594	40	2·40	60	23·1	4	—	0·6
3093	40	1·95	53	23·0	5	16	0·8
4394++.. ..	40	1·06	120	20·8	5	—	—
Ma/62/428 ..	35	1·85	81	22·5	4	—	0·5
Ma/62/57 ..	25	1·78	98	22·0	3	—	0·5
Mo/68/1132 ..	—	1·90	54	—	4	—	2·9
Mo/68/1122 ..	—	1·30	—	—	3	—	4·1

+ 1 means extreme lodging, 5 means no lodging at all.

++ Triploid

Diallel cross

Four clones (1171, 2525, 4331 and Ma/63/1890) were crossed in all possible combinations. The parent values are shown in Table 11.

Table 11—Relative Flower Yield, Pyrethrins Contents and Flower Size of 4 Parent Clones

Clone	Relative flower yield per cent	Pyrethrins content per cent	Fresh weight of 100 fllowers (g)
Ma/63/1890	25	2·15	65
2525	30	1·95	87
4331	100	1·60	63
1171	60	1·35	95

In total 12 crosses were made. The reciprocal crosses were taken together as no differences were observed. In this way 6 hybrids were tested. Table 12 gives the results together with the mid-parent values.

Table 12—Relative Flower Yields, Pyrethrins Contents and Flower Sizes of Six Hybrids and of the Mid-Parents

Hybrid	Estimated Flower Yield		Pyrethrins Content Per Cent		Flower Sizes gm.	
	Hybrid	Mid-parent	Hybrid	Mid-parent	Hybrid	Mid-parent
Ma/63/1890 x 2525	20	28	1·94	2·05	60	76
Ma/63/1890 x 4331	40	63	1·88	1·88	64	64
Ma/63/1890 x 1171	40	43	1·68	1·75	79	80
2525 x 4331	50	65	1·74	1·78	68	75
2525 x 1171	40	45	1·57	1·65	80	91
4331 x 1171	65	80	1·43	1·48	78	79

The results of the hybrids agree very well with the mid-parent values for pyrethrins content and flower size but less so for flower yield. This confirms former more elaborate data obtained from the progenies of a polycross. This trial again showed how wide the yields of hybrids (single cross) vary. The best one here, 4331 x 1171 is considered as a fair hybrid but considerably less yielding than the recommended ones like K.73. P2 and P4. The same data were also collected for dry matter content of the flower. They varied between 21.8 per cent and 22.7 per cent, a range too narrow to compare with the mid-parent values.

Top Cross

To evaluate the general combining ability of a number of clones, 44 clones were planted in a field of seedlings of M42 and M118, which were planted alternately. Sufficient seed was obtained for most of the clones and although the quality of the seed varied greatly, the seed was sown in November 1970 to plant a top-cross-progeny trial in April 1971.

Clone yield trials

The 1969 replicated clone yield trials have been terminated and a number of clones appear to be very promising. 0/63/33 was tested in 1965/66 in Ol Joro Orok and did quite well there. In Marindas it was extremely well yielding, outyielding clones like 4729 and 4026 with 30 to 40 per cent at a pyrethrins content of 1.90 per cent. It is a slow starter but yields heavily in the second season. It has a tendency to lodge. Ma/65/450 and Ma/66/439 were also very promising yielders at a pyrethrins content of 1.85 and 1.95 per cent respectively. Of a similar yield level were clone Mo/66/181, content 1.90 per cent and the varieties K.73 and P2, contents both 1.80 per cent. 0/66/594 and 0/66/617 although not as high yielding as the former ones, were very high in content, 2.40 and 2.10 per cent respectively. Of the Feingold clones tested F5 seems to be the best yielder, comparable to clone 4729 at a content of 1.80 per cent.

In the 1970 replicated clone yield trials one clone is worth mentioning already. Ma/65/252, although coming from poor splits, yielded outstandingly in the first season at a pyrethrins content of 2.25 per cent.

Clonal selection in Kisii district

Varietal and clonal selection has always been concentrated on the Rift Valley region. Since Kisii is now a large producer of pyrethrum flowers, it is necessary to summarize the accumulated knowledge of clonal selection in this area.

As early as, 1963 Contant recognized the yielding potential of local Kisii clones. He brought a fairly large number of local clones to the Kisii Agricultural Research Station (1,700m) and screened these for flowering at a low altitude. The 19 best clones

were planted together with 9 high yielding Rift Valley clones in a replicated yield trial near Keroka (2,000m). Table 13 gives the results of the best clones. In 1969 and 1970 replicated trials planted at Keroka and Nyosia, substantiated these findings. In two screening trials a number of local Kisii clones and Rift Valley clones were tested. None of the 41 local clones and 7 out of 28 Rift Valley clones were selected for further testing.

TABLE 13—RELATIVE FLOWER YIELDS AND AVERAGE PYRETHRINS CONTENTS OVER A THREE-YEAR PERIOD AT KEROKA

Clone	Relative flower yield	Pyrethrins content
4331	86	1·55
4049	69	1·55
4098	66	1.62
4729	66	1·58
KS/63/11	64	1·83
KS/63/229	61	1·82
KS/63/41	55	1·84
KS/63/42	55	1·85

The trials carried out so far suggested that KS/63/11 and KS/63/229 represent the best local clones and that among the material selected for Rift Valley conditions clones are found surpassing the locally adapted material.

Pollen viability and storage

Pollen of pyrethrum was very difficult to handle. It lost its viability fast and it could not be germinated *in vitro*. Mr. Hoekstra, a Dutch student, developed a method to germinate the pollen *in vitro* and a method to store viable pollen, important in all breeding work.

To germinate pollen *in vitro* pollen is taken from the flower just after dehiscence and brought onto a slide. The slide is placed at 100 per cent relative air humidity at 30°C for ca 20 minutes (water bath at 30°C). This is to activate the pollen. After this activation treatment the germination medium is brought onto the slide and mixed with the pollen. This medium consists of distilled water with 1.32 Mol. of sacharose, 0.002 Mol Ca(OH)2 and 100 ppm. Boric acid, adjusted to a Ph of 6.8 with phosphoric acid. The pollen germinate quickly in this medium and to count the germination pollen the slide is brought under the microscope after colouring with aniline blue (Martin, Stain Technol. 34, 1959: 125-127) and illuminated with ultraviolet light. (Kho and Baer, Euphytica 17, 1968, 298-302).

Pyrethrum pollen can be stored and transported by air mail f.i. without loss of viability. To this end pollen has to be collected just after dehiscence on sunny, dry days and dried immediately. This is done in a container above sodium hybroxide pellets for 10 to 12 hrs. After this the pollen is packed in sealed plastic bags with as little air as possible and stored in a cool place. In the freezing department of refrigerator it was kept viable for several months.

As it is now possible to measure the viability of pyrethrum pollen an investigation was done into the effect of the weather. Low temperatures and high relative humidity (RH) retards the dehiscence, which results in a decrease of viability. High RH also results in an enhanced activity, which shortens the period of viability. Under practical conditions where it takes some time to bring the pollen to the styles, the high RH results in lower viability at time of pollination. Dry and warm weather on the other hand enhances dehiscence, retards activation and due to insect activity results therefore in pollination with very viable pollen.

Wet and cold weather, not only gives poor pollen, which is transported slowly (few insects), it also slows down germination and penetration of the style. Many factors therefore work together to bring forward very poor seed setting during cold, wet periods (July-August) and good seed setting during warm, dry periods (February).

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NATIONAL HORTICULTURAL RESEARCH STATION, THIKA

Vegetable Crops (Other than Potatoes)—J. N. Warui

Tomatoes.—A variety trial which tested four of the varieties included in the 1969 trial, i.e. Rutgers, Roma, Best of All, and Money Maker was laid down as a randomized block. The trial was direct seeded on 10/4/70 and germination was good. Farmyard Manure was applied at the rate of 50 tons per hectare together with diammonium phosphate at the rate of 300 kilogrammes per hectare. Both these were applied before planting. The plots were then topdressed with calcium ammonium nitrate (26 per cent N) one month after planting.

Fruit ripening started 108 days after planting and harvesting continued for 2½ months. Regular sprays of M.45 Dithane alternately with a 50 per cent W.P. copper formulation were carried out to control blight (*Phytophthora infestans*). Thiodan 35 per cent M.L. was applied to control American Bollworm (*Heliothis amigera*). Supplementary irrigation of 433.07 mm was applied during the season. Table I below shows the means.

Table I—Mean Yield of Tomatoes (Tonnes Per Hectare)

Variety	*Yield*
Rutgers	51·97
Money Maker	83·22
Roma	38·13
Best of All	65·18

Coefficient of Variation=12%
L.S.D. p=0·05=11·13; p=0·01=15·99; p=0·001=23·52

The figures show the superiority of variety Money Maker over the others. The minimum economic yield is estimated at 75 tonnes per hectare.

Pruning Trial.—Using variety Money Maker, a pruning trial was carried out to determine the best method of pruning tomatoes for the fresh market. One, two, three and four stem systems were tried in a randomized block design. The fertilizer and manure rates used in the variety trial described above were used in this experiment. The results are shown in Table II.

Table II—Tomato Pruning Trial Mean Yield of Tomatoes
(Tonnes per hectare)

Treatment (*Pruning method*)	*Yield*
One stem	39·37
Two stems	50·02
Three stems	72·39
Four stems	72·06

Coefficient of Variation 25%
L.S.D. p=0·05=23·71

From the data in Table II it is evident that the three stems method gives the highest yields and could therefore be used for pruning tomatoes destined for the fresh market.

Onions for Dehydration.—Following the 1969 investigations, further onion varieties were tried in 1970, with a view to finding high yielding and high dry matter varieties suitable for dehydration. The crops were grown under supplementary irrigation of 558.8 mm during the growing season as the short rains failed. Farmyard Manure at the rate of 50 tonnes per hectare and double superphosphates at the rate of 250 kilogrammes per hectare were applied before planting. Calcium ammonium nitrate (26 per

cent N) was topdressed 3 months after planting. Regular sprays of M.45, Dithane and 50 per cent M.L. malathion were applied to control Purple Blotch and thrips respectively. The results of the experiment are summarized in Table III. All the varieties were found suitable except yellow Bermuda which was not white as required by the processors:—

TABLE III—MEAN YIELD OF ONION VARIETIES FOR DEHYDRATION
(Tonnes per hectare)

Variety	*Mean Yield*	*Assessment*
Hybrid No. 3	33·77	Good
Yellow Bermuda	19·58	Unsuitable
White Creole	24·17	Good
Giza (Egyptian)	43·92	Very good
Yellow Granex	73·33	Fair
F. 1 Hybrid	57·60	Satisfactory

Coefficient of Variation = 8·7%
L.S.D. p = 0·05 = 5·4

Commercial trials were recommended for layout in Lake Naivasha area to try Giza, Yellow Granex, F.1 Hybrid and Hybrid No. 3.

Capsicums.—A variety trial was conducted as a follow-up on the work done previously to introduce newer varieties of capsicums. This trial contained 9 varieties which were laid out in a randomized block design with four replicates. Seedlings were raised in a nursery and transplanted eleven weeks later in a field dressed with manure at the rate of 50 tonnes per hectare and double superphosphate (46 per cent P_2O_5) at the rate of 200 kilogrammes per hectare.

Plants were topdressed with calcium ammonium nitrate (26 per cent N) in 2 applications of 200 kilogrammes per hectare each one month and two months after planting. Irrigation of 431.8 mm was applied during growth.

TABLE IV—MEAN YIELD OF CAPSICUMS
(in Tonnes per hectare)

Variety	*Yield*
Chinese Giant	8·11
Midway	6·49
California Wonder Select ..	8·36
Ruby King	11·24
Thick World	9·61
Mercury	10·62
Yolo Wonder	10·91
California Wonder ..	6·64
Titan	7·65

Coefficient of Variation 19·35%
L.S.D. p=0·05=2·41

The results point to the superiority of Ruby King, Mercury and Yolo Wonder varieties over the rest. Yolo Wonder is a popular variety in Kenya but is susceptible to mildew and sunscorch.

French Beans.—Varieties of french beans previously not grown in Kenya were introduced and tested together with the popularly grown types. The aim was to assess their performance in growth, yield and pest and disease susceptibility. Nine varieties were included in a randomized block design with four replicates. The seed was dressed

with Agrosan GN at the rate of 14 grammes per 5 kilogrammes of seed (to prevent Beanfly damage) before planting. Double superphosphate (46 per cent P_2O_5) was applied at the rate of 100 kilogrammes per hectare before planting and a topdressing with sulphate of ammonia (21 per cent N) at the rate of 100 kilogrammes per hectare when plants were 15 centimetres high. The crop was grown during the rainy season and only 152.4 mm of irrigation was applied.

Table V—Mean Yield of French Bean Varieties
(Green pods in tonnes per Hectare)

Variety	*Yield*
Canadian Wonder.. ..	21·71
Double Dutch Princess ..	8·95
Top Crop	12·52
Masterpiece	18·30
Black Wonder	14·70
Tendergreen	15·70
Contender	18·32
Richmond Wonder ..	19·00
Seminole	14·20

Coefficient of Variation 11%
L.S.D. p=0·05=2·70

The yields are higher than normally achieved. This was mainly due to late harvesting as a result of labour shortage at the right harvesting time.

Variety Canadian Wonder is normally grown as a dry bean and not as a green bean.

Carrots.—A new variety of carrot named Oxheart was tried together with the popular Nantes and Chantenay varieties in a randomized block experiment with 3 replicates. Although it yielded well it had poor quality because it was fibrous and the core unattractive. Table VI shows the results in tonnes per hectare.

Table VI—Yield of Carrots

Variety	*Yield*	*Quality*
Nantes	10·19	Good
Chantenay	12·59	Good
Oxheart	18·26	Poor

Coefficient of Variation 22%
L.S.D. p = 0·05 = 3·91

Fruit Crops

Passion Fruit—S. P. Gachanja

The fertilizer trial reported in 1969 was continued during 1970. The trial was severely damaged by Brown Spot (caused by *Alternaria passiflorae*). The yields in Table VII were recorded during the year.

Table VII—Effects of Fertilizers on Yiled of Passion Fruit on a Murram Soil
(Fresh fruit tonnes per hectare)

Treatment:			*Yield*
A	No fertilizers:		28·2
B	11·35 kg Nitrogen	11·35 kg Phosphorus	11·35 kg Potash/hec 28·2
C	27·70 „ „	45·40 „ „	45·40 „ „ „ 29·8
D	90·80 „ „	68·10 „ „	68·10 „ „ „ 30·1
E	90·80 „ „	136·10 „ „	90·80 „ „ „ 33·2
F	181·60 „ „	225·80 „ „	225·80 „ „ „ 29·2

The results show that there was no response to heavy fertilization on the murram soil. In the event of severe Brown Spot attacks the actual effect of fertilizer could not be gauged. A further trial will be planted in 1971 on better soil and more intensive Brown Spot control regime. It should be noted that all the plots yielded about 10 tonnes per hectare more than in 1969 when they had less than 20 tonnes in each treatment. It is interesting to note also that the yields were much higher than is usually anticipated from commercial plantations where average yields do not exceed 15 tons per hectare.

Pineapples—D. K. Puri

Preplant Fumigation with D.B.C.P. (Nemagon), D.D. and E.D.B.

This trial was laid down in March, 1968 at the main station to find out the most effective of the commercial fumigants available and also to determine their optimum rates of application.

Design of the trial was randomized blocks with four replicates and a recorded plot size of 12.5 square metres giving a total of 60 plants per plot. The fumigants tested were:—

1. Nemagon 75 per cent M.L. at 22 litres per hectare of active ingredient.
2. Nemagon 75 per cent M.L. at 44 litres per hectare a.i.
3. Nemagon 75 per cent M.L. at 66 litres per hectare a.i.
4. D-D at 225 litres per hectare.
5. D-D at 337.5 litres per hectare.
6. D-D at 450 litres per hectare.
7. E.D.B. Terrafume 45 per cent Liquid at 56 litres per hectare a.i.
8. E.D.B. Terrafume 45 per cent Liquid at 84 litres per hectare a.i.
9. E.D.B. Terrafume 45 per cent Liquid at 112 litres per hectare a.i.
10. Control (No Treatment).

The whole experimental area was fumigated by a soil injector 20 cm deep and 30.5 apart in double rows of 45.75 cm by 91.5 cm. Fumigation was followed by fairly heavy long rains.

Table VIII—Gives a Summary of the Total Yield and Quality Mean Yield of Fruit in each Grade in Tons per Hectare

Treatment	Grade I	Grade II	Grade III	Total Plant Crop
1. Nemagon 22 litres per hectare ..	58·34	16·66	1·39	76·39
2. Nemagon 44 litres/ha	51·30	22·78	0·88	74·96
3. Nemagon 66 litres/ha	54·14	19·99	3·08	77·21
4. D–D 225 litres per hectare	51·00	14·14	0·21	65·35
5. D–D 337·5 litres/ha	60·96	14·18	0·25	75·39
6. D–D 450 litres/ha	68·87	8·91	1·41	79·19
7. E.D.B. 56 litres/ha	51·93	25·51	0·75	78·19
8. E.D.B. 84 litres/ha	62·83	13·25	1·07	77·15
9. E.D.B. 112 litres/ha	66·59	12·78	0·59	79·96
10. Control	47·36	23·79	1·98	73·13
L.S.D. p = 0·05	N.S.	9·54	N.S.	N.S.

Coefficient of Variation for Plant Crop Total = 10·38%

From the data in Table VIII, there were no statistically significant differences between the control and the other treatments. However, with regard to fruit size of Grade II the control treatment is superior to all rates of D-D and also the higher rates of E.D.B. Higher rates of E.D.B. appear to show a depressing effect on fruit size. The low rate of E.D.B. gave better quality fruit than all the rates of D-D.

The results of this trial point to the fact that fumigation may not be all that necessary. Perhaps the results of the ratoon crop may show advantages of fumigation. If the ratoon crop does not give positive response then it might be necessary to carry out a similar trial on the same site with same treatments in order to see the effect of fumigation in the 3rd cycle.

Plant Population.—This trial was planted on 1.4.68 to determine the optimum plant population. Design of the trial was randomized blocks with four replicates and a recorded plot size of 12.5 square metres. Treatments were as follows:—

1. 46,100 plants per hectare.
   Double rows using a spacing of 96.5 cm x 45.75 cm x 30.5 cm.
2. 47,800 plants per hectare.
   Double rows using a spacing of 91.5 cm x 45.75 cm x 30.5 cm.
3. 53,800 plants per hectare.
   Double rows using a spacing of 76.0 cm x 45.75 cm x 30.5 cm.
4. 43,000 plants per hectare.

Control. Double rows using a spacing of 106.7 cm x 45.75 cm x 30.5 cm.

The plant crop was harvested from 20th December, 1969 to 18th March, 1970. Table IX summarizes the yield data in terms of total yield and fruit size.

Table IX—Mean Yield of Fruit in each Grade in Tons per Hectare

Treatment	Grade I	Grade II	Grade III	Total Plant Crop
1. 46, 100 plants/ha.	53·17	20·84	1·11	75·12
2. 47,800 plants/ha.	55·74	23·99	1·05	80·78
2. 53,800 plants/ha.	46·48	36·85	0·66	83·99
4. 43,000 plants/ha.	42·83	25·32	0·81	68·96
Control				
L.S.D. @ 5%	N.S.	9·02	N.S.	5·55
1%	N.S.	12·97	N.S.	7·97
0·1%	N.S.	N.S.	N.S.	11·73
C of Variation	14·78%	21·07%	20·96%	4·49%

Increasing plant density shows a significant increase in both total yield and Grade II fruit. Owing to the differences in fruit size requirements between the canning industry which requires large pineapples and the fresh market which requires smaller fruit a plant population of 53,800 may be recommended for the latter and 47,800 plants per hectare for the former.

New Pineapple Trial

The trial was planted on 25.4.67 to study the value of black polythene mulch under two fertilizer schedules involving the use of basal applications of sulphate of ammonia and urea foliar sprays.

Plot Design.—Randomized block with four replicates. Recorded plot size 70 square metres.

Treatments were as follows:—

A. Polythene mulch only; No fertilizer.

B. No polythene mulch; No fertilizer. CONTROL

C. Polythene Mulch; plus Phosphate at the rate of 90 kg P_2O_5/ha; Nitrogen at the rate of 472 kg/ha in 4 applications of 118 kg.N. each.

D. Polythene Mulch; plus Phosphate at the rate of 90 kg P_2O_5/ha; Potash at the rate of 225 kg K_2O/ha; Nitrogen at the rate of 118 kg/ha aside dressed 1 month after planting. Urea monthly foliar sprays from the 4th to the 14th month at 84 kg. Urea—46 per cent N per ha.

E. As (D) but without Polythene Mulch.

F. Polythene Mulch; plus Phosphate at the rate of 90 kg P_2O_5/ha. Urea monthly foliar sprays as in D.

As the above treatments were applied to the plant crop results of which were reported in Part II of the Annual Report 1969. Treatments for Ratoon crop were:—

A. No Fertilizer.

B. No Fertilizer.

C. Nitrogen at the rate of 118 kg N/ha applied after pruning.

D. Urea monthly foliar sprays commenced on

E. 10.6.69 at the rate of 50 kg Urea—46 per cent N per ha.

F. for 8 months.

The Ratoon crop was harvested from April, 1970 to September 1970. The results appear in Table X.

TABLE X—MEAN YIELD OF PINEAPPLE FRUIT EACH GRADE—TONS/HECTARE

Treatment	Grade I	Grade II	Grade III	Total Ratoon Crop
A	0·19	3·24	4·22	7·65
B.	0·17	2·18	3·49	5·84
C.	12·23	20·20	5·77	38·20
D.	18·69	16·90	5·78	41·37
E.	10·44	11·67	4·68	26·79
F.	15·62	16·74	4·98	37·34
L.S.D. @ 5%	5·38	4·52	N.S.	8·52
1%	7·44	6·25	N.S.	11·78
0·1%	10·38	8·64	N.S.	16·28
C. of Variation	37·39%	25·38%	47·71%	21·56%

Polythene mulching gave significant increases in total plant crop and grade II fruit when comparing treatments C, D and F with E.

On the basis of Grade I it appears that foliar sprays are superior to ground application of nitrogen. Treatment D illustrates this when compared with C. However, there is no significant difference in use of the form of nitrogen with regard to Grade II

POTATOES—C. C. Ballestrem

Experiments to determine response by potatoes to application of various combinations of nitrogen, phosphorus and potassium were conducted on two sites during 1970. In one case no response was obtained from the use of potassium fertilizers. A 3^3

factorial layout experiment to test the effect of N, P and K was conducted with the following treatment levels:—

N_1 = 0 kg. N/ha.	P_1 = 0 kg. P_2O_5/ha.	K_1 = 0 kg. K_2O/ha.
N_2 = 75 kg. N/ha.	P_2 = 150 kg. P_2O_5/ha.	K_2 = 100 kg. K_2O/ha.
N_3 = 150 kg. N/ha.	P_3 = 300 kg. P_2O_5/ha.	K_3 = 200 kg. K_2O/ha.

Nitrogen was applied as CAN (26 per cent N), Phosphorous as DSP, (44 per cent P_2O_5) and sulphate of potash (50 per cent K_2O) was the potassium form used. The trial was laid out at two sites, Thika and Molo using potato variety B53 (Rosylin Eburru). At Thika the experiment was carried out during the long and short rains while at Molo it was planted in the long rains only. Fertilizers were applied along the planting lines at planting time. Each crop duration was four months. Irrigation was applied in each case to make up for moisture deficits. The results obtained are shown in Tables XI, XII and XIII.

TABLE XI—MEAN YIELDS OF POTATOES IN TONNES PER HECTARE (MOLO STATION)

	N_1	N_2	N_3	K_1	K_2	K_3	Mean
P1	20·47	22·45	17·27	21·47	18·50	18·38	19·59
P2	35·03	51·06	51·02	35·03	39·22	32·56	40·65
P3	35·27	49·33	65·37	35·27	30·34	35·27	41·81
K1	21·47	24·45	17·27				21·06
K2	18·50	24·42	22·20				21·70
K3	18·38	23·93	29·11				23·81
Means	24·67	32·27	32·04				

Coefficient of Variation 19·06%

	5%	1%	·1%
L.S.D.			
Main effects	2·62	3·48	4·53
Within 3 × 3 Tables ..	4·56	6·06	7·89

There were significant responses to both nitrogen and phosphorus but not to potassium treatments. Best yields were achieved where both nitrogen and phosphorus were applied.

TABLE XII—MEAN YIELDS OF POTATOES IN TONNES PER HECTARE THIKA LONG RAINS 1970

	N_1	N_2	N_3	K_1	K_2	K_3	Mean
P_1	14·80	18·10	14·10	14·80	14·10	19·80	15·95
P_2	22·75	30·19	31·23	22·75	20·51	20·91	24·72
P_3	26·09	32·56	34·19	26·09	30·34	23·38	28·74
K_1	14·80	18·10	14·10				15·69
K_2	14·10	18·50	21·95				18·18
K_3	20·91	21·86	17·86				20·21
Means	18·91	23·21	22·22				

Coefficient of Variation 17·86%

	5%	1%	·1%
L.S.D.			
Main treatments	1·32	1·76	2·28
Within the × 3 Tables ..	2·28	3·03	3·94

It can be observed that the response to fertilizers is similar to the observations at Molo but the yields at Thika were lower in all cases.

TABLE XIII—MEAN YIELDS OF POTATOES IN TONNES PER HECTARE
THIKA—SHORT RAINS 1970

	N_1	N_2	N_3	K_1	K_2	K_3	Mean
P_1	9·05	13·67	10·53	9·05	12·08	12·01	11·19
P_2	16·97	32·41	35·00	16·97	22·87	18·20	23·57
P_3	18·80	34·21	36·93	18·20	19·65	19·68	27·74
K_1	9·05	13·67	10·53				11·08
K_2	12·88	12·97	12·65				12·86
K_3	12·01	14·95	14·58				13·84
Means	12·97	20·31	20·03				

Coefficient of Variation 18·90%

	5%	1%	·1%
L.S.D.			
Main effects	3·19	4·29	5·64
Within the 3 x 3 Tables	5·53	7·43	9·76

No significant response was obtained with potassium but highly significant responses were obtained with phosphorus and nitrogen. Foliar analyses to determine the uptake of the three elements were undertaken at intervals during growth of the crops. Highly significant correlations were found between the fertilizer treatments and the leaf content of nitrogen and phosphorus.

Economic considerations indicate that it would not pay to apply more than 150 kilogrammes of nitrogen and 150 kilogrammes of P_2O_5 per hectare respectively.

Thus an expenditure of about KSh. 700 per hectare on fertilizers is adequate. A yield of 25 to 28 tonnes per hectare will be achieved under Thika conditions while in the Molo area yields of over 40 tonnes per hectare should be achieved using the same rates of fertilizers as in Thika.

Publications:—

Waithaka, J. H. G. and Mugo M. J.

"Possibilities for Growing Deciduous Fruit Trees in Kenya."

"Technical Comm. No. 21 of International Society for Horticultural Science. Feb. 1970."

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A.—Weather

The weather during 1970 was very favourable for cane growing in Nyanza, Rift Valley and Western Provinces. The rainfall was above average and well distributed throughout the year. As usual, the Long Rains set in by March and continued until early June when they began to tail off. Similarly, the Short Rains arrived timely in October and continued until mid-December. At the Coast, however, the weather was not so favourable. The Long Rains never started until April, and both February and March were characterized by drought. Furthermore, Short Rains did not start until November and they were well below average.

Nevertheless, the total rainfall received and its distribution in Western Kenya and at the Coast were superior to that for 1969, and therefore this should result in slightly better cane yields. Monthly rainfall of selected stations in cane growing areas are presented in Appendix I.

B.—Reports on Experiments

1. Cane Breeding

The raising of cane seedlings and the selection of such seedlings for subsequent bulking at Kibos was carried out at the Western Agricultural Research Station, Kakamega.

(a) Seedlings of the E.A. '69 series

27 selections were made from the First Year Seedling Trial at Kakamega and planted in a Second Year Seedling Trial at Kibos in June. The details of the selections, including their percentage are presented in appendix 2.

(b) Seedlings of the E.A. '70 series

132 selections were made at Kakamega from the 3,433 seedlings in the First Year Seedling Trial of this series and planted in the multiplication plots at Kibos in November, before they could be advanced to the Second Year Seedling Trial. Of these selections only 125 selections germinated and survived due to drought. These will be selected and advanced to the Second Year Seedling Trial in the Long Rains of 1972. The details of the crosses of the selections in this series are given in Appendix 3.

(c) Seedlings of the E.A. '71 series

119 crosses of this series were planted from October, 1969 to January, 1970, and only 92 crosses germinated. From the germinated crosses a total of 58,792 seedlings were potted between February and May, 1970, and these were subsequently transplanted in the field as First Year Seedling Trial for this series in August. The details of the crosses and the number of seedlings in each cross planted in the First Year Seedling Trial are given in appendix 4.

(d) Introductions

Several important commercial varieties from other cane growing countries introduced through E.A. Quarantine Station at Muguga were bulked and screened for smut resistance in the Smut Blocks before being tested in the variety trials. The details of the varieties introduced and smut tested are presented in appendices 5a, 5b and 5c.

Variety Trials

A third ratoon variety trial evaluating the yields of six varieties in a 6×6 Latin Square design was harvested at Lunza in February, 1971. The results of cane yield for the four crops and juice analyses for the third ratoon are given in Table 1.

TABLE 1—MEAN CANE YIELD IN TONS/ACRE FOR FOUR CROPS AND JUICE ANALYSIS OF THE VARIETY TRIAL AT LUNZA

Variety	Cane Yield					Juice Analysis for 3rd Ratoon			
	Plant Crop	1st Ratoon	2nd Ratoon	3rd Ratoon	Total	Brix	Pol	Purity	Fibre
N:Co 293 ..	44·27	21·63	53·80	40·00	159·70	24·20	13·50	90·00	14·50
Co. 467 ..	56·39	19·78	41·77	34·70	152·64	23·40	13·80	91·60	13·80
N: 50–211 ..	51·38	21·49	37·49	37·10	147·46	24·00	12·90	89·70	15·60
N: Co. 310..	38·57	10·90	40·27	28·40	118·14	25·50	13·80	90·10	15·60
Trojan ..	36·42	7·91	23·51	15·10	82·94	24·60	14·00	92·10	15·10
B. 41227 ..	*	*	43·13	38·13	81·84	23·30	13·70	92·00	14·00
Mean ..	45·41	16·34	40·00	32·33	123·79	*Values Missing			
S.E. ..	±8·894	±5·67	±8·25	±7·62	L.S.D.		5%	1%	
C. of V. ..	19·6%	35·4%	20·6%	23·5%			15·90	21·69	

The variance analysis of cane yields for the third ratoon shows that although the differences among Co. 467, NL 50-211 and B. 41227 are not statistically significant, these varieties significantly outyielded Trojan at 1 per cent level. The very low mean cane yields for Trojan and N:Co. 310 indicate that these varieties are not adaptable to the environmental conditions at Lunza. As in the previous three crops, N:Co. 393 was again the most outstanding cane yielder of the varieties tested. However, since this variety display marginal smut resistance, its outstanding cane yielding ability should be treated with reserve.

The total cane yields for the four crops show substantially very low yields for the first ratoon. This is due to the fact that the trial suffered badly from poor management during the first ratoon. Nevertheless, the mean cane yields of the other three crops are considered quite good for a soil normally regarded as very poor for any other crops. These yields indicate that substantial response in cane yield is to be expected when better management and fertilizers are applied to sugar-cane crops on this soil.

The very high brixes displayed by all the varieties are a reflection of the very severe drought which prevailed for two months just before the trial was harvested. This trial has to be discontinued since it is difficult to ensure good management. Damage by straying cattle and theft coupled with the inability of the farmer to carry out timely weeding preclude obtaining reliable results from the trial.

A second ratoon variety trial was harvested at Mumias Chief's Camp in January, 1971. The trial tested the yields of 6 clones in 4 replicates of a randomized block design. Table 2 is a summary of the mean cane yields for the three crops and juice analysis for the second ratoon crop.

Table 2—Mean Cane Yield in Tons/Acre for three Crops of the Variety Trial at Mumias Chief's Camp

Variety	Cane Yield			Juice Analyses for 2nd Ratoon				
	Plant Crop	1st Ratoon	2nd Ratoon	Total	Brix	Pol	Purity	Fibre
N: 50–211 ..	68·49	59·43	42·70	170·62	18·90	16·60	87·60	12·30
B. 41227 ..	54·72	55·72	38·50	148·94	19·10	16·40	85·70	13·10
N:Co. 292..	52·76	57·50	36·70	146·96	20·80	18·70	89·80	13·00
Co. 205 ..	48·64	38·30	38·80	145·74	*	*	*	*
N:Co. 310..	47·54	50·14	32·00	129·68	22·20	20·30	91·30	11·10
P.O.J. 2822	27·76	38·98	20·10	86·84	18·80	16·50	87·90	10·80
Mean ..	49·99	53·34	34·80	138·13	*Values Missing			
S.E. ..	±10·78	±8·52	±6·00	L.S.D. ..	5%	1%		
C. of V. ..	21·6%	16·0%	11·5%		12·79	17·68		

The data show that in the second ratoon, crop yields for the first five varieties were not significant ($P < 0.05$). However, P.O.J. 2833 has been significantly outyielded by N:50-211, B. 41227 and Co. 205 ($P < 0.01$). Similarly, it has been outyielded by N:Co. 293 the difference in yield being significant at $P = 0.05$.

The total and mean cane yields show that N:50-211 is superior to all other varieties in this trial. However, this variety (N:50-211) has many thin stalks which lodge badly towards maturity. It is therefore doubtful if farmers and cane cutters could readily accept it. All the five sampled varieties displayed satisfactory juice qualities.

Three 1st ratoon crop variety trials were harvested at Kibos in January, 1971. The trial tested the ratoon yields of 18 varieties using three separate squares of 6×6 Latin Square design. The mean cane yields and juice analyses of the three trials are summarized in Tables 3a, 3b and 3c.

Table 3*a*—Mean Cane Yield in Tons/Acre and Juice Analyses of Plant and 1st Ratoon Crops of the First Variety Trial at Kibos

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
N. 50–211 ..	107·46	74·14	181·60	17·89	15·66	87·73
Co. 421	101·82	74·88	176·70	18·37	16·42	89·38
Co. 440	96·07	84·05	180·12	19·36	17·09	88·27
H. 32–1063 ..	93·65	62·50	156·15	19·11	17·18	89·90
BADILA.. ..	79·40	59·76	139·16	19·17	17·17	89·56
P.R. 1007 ..	74·72	42·38	117·10	18·92	16·78	88·68
Mean	92·19	66·29	158·48			
S.E.	±9·219	±12·280				
C. of V.	10·0%	18·5%				

TABLE 3*b*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE SECOND VARIETY TRIAL AT KIBOS

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 467	97·17	69·23	166·60	18·84	16·70	88·64
B. 47419 ..	93·34	63·51	156·85	20·09	18·41	91·63
Q. 47	89·05	66·69	155·74	19·38	17·76	91·64
Co. 331	80·29	65·33	145·62	19·69	17·70	89·89
Co. 1001	75·72	56·74	132·46	20·38	18·57	91·11
P.R. 905 ..	66·66	48·08	114·74	*	*	*
Mean	83·70	61·60	145·30	*Values Missing		
S.E.	±8·08	±7·19	L.S.D.	5%	1%	
C. of V.	9·7%	11·7%		15·01	20·47	

TABLE 3*c*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE THIRD VARIETY TRIAL AT KIBOS

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 680	99·86	66·56	166·42	19·98	17·76	88·88
Co. 746	98·48	63·64	162·12	20·30	17·68	87·12
N: Co. 293 ..	93·52	63·07	156·59	21·05	18·34	87·12
H. 39–5803 ..	87·88	61·22	149·10	21·13	18·75	88·73
M. 423/41 ..	83·79	65·25	149·04	20·08	177·77	88·49
P.O.J. 2822 ..	58·38	38·92	97·30	20·51	18·55	90·44
Mean	86·98	59·77	146·75			
S.E.	±8·88	±6·71		5%	1%	
C. of V.	10·2%	11·2%	L.S.D.	14·00	19·10	

The statistical analysis of cane yields for the first trial showed that there was no significant differences among the first five varieties. However, the first three varieties significantly outyielded P.R. 1007 at 5 per cent level of significance. There was considerable decline in cane yield in all the varieties. The magnitude of the yield decline was highest in P.R. 1007 but least in Co. 440, being 43 per cent and 12 per cent, respectively. The very poor performance of P.R. 1007 clearly indicated that this variety was unadapted to the environmental conditions under which the experiment was conducted. The combined plant crop and ratoon crop yields indicated that both N:50-211 and Co. 440 were superior to Co. 421 which is a standard commercial variety grown in parts of Kibos, and which is claimed by some of the cane farmers in the area to be a better cane yielder than the traditional Co. 331. However, relatively poor juice quality displayed by N:50-211 in the plant crop is again repeated in present first ratoon. This makes N:50-211 of doubtful commercial potential.

The yield data for the second crop showed that although the first four varieties were not statistically different among themselves, they were all significantly better than P.R. 905.

A scrutiny of mean cane yields shows that B. 47419 displayed the highest decline, resulting in its drop from 2nd position in the plant crop to the 4th position in the 1st ratoon. Furthermore, Co. 467, B. 47419 and Q. 47 have convincingly beaten the present standard commercial variety, Co. 331. However, it is noteworthy that Co. 331 displayed the least cane yield decline, and this tends to support the farmers' claim that this particular variety gives many more ratoons in Kibos-Miwani areas than any of the varieties so far tested and grown commercially in the area.

All the varieties displayed satisfactory juice quality with B. 47419 repeating its plant crop lead at harvest.

In the third trial the first five varieties, while not significantly different among themselves, they were significantly better than P.O.J. 28229. All varieties showed marked decline in cane yield with Co. 680 displaying the biggest drop and M.423/41 the least drop. The combined yields of plant and first ratoon crops show that Co. 680 and Co. 746 still retained their higher plant crop cane yield. All the varieties had relatively better juice quality in the 1st ratoon than in the plant crop.

The results of the three trials suggest that Co. 440, Q. 47, Co. 680 and Co 746 compare very favourably with the present two standard commercial varieties in the area, Co. 421 and Co. 331; and if the present trends continue in the 2nd ratoon crops, then these varieties may be as replacements of Co. 421 and Co. 331 for commercial cultivation.

Three other 1st ratoon crop variety trials were harvested at Miwani in May, 1971. The three trials evaluated the ratoon yields of 18 clones using three separate squares of a 6×6 Latin Square design. The mean cane yields and juice analyses for the two crops of the three trials are presented in Tables 4a, 4b and 4c.

TABLE 4*a*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE FIRST VARIETY TRIAL AT MIWANI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Col. 746	78·21	49·06	127·27	22·05	19·33	87·66
Co. 331	66·67	44·15	110·82	21·06	18·35	87·13
N: Co. 293 ..	66·29	49·61	115·90	21·97	19·27	87·71
Q. 47	62·25	46·15	108·40	21·10	18·33	86·87
CP. 29/291 ..	59·00	42·97	101·97	22·89	20·15	88·02
Co. 449	55·48	39·52	95·00	22·75	20·22	88·87
Mean	64·65	45·24	109·89			
S. E.	±3·05	±7·90				
C. of V.	4·7%	17·5%				

TABLE 4*b*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE SECOND VARIETY TRIAL AT MIWANI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 440	73·46	52·20	125·66	22·46	19·82	88·24
Co. 467	72·12	50·46	122·58	23·31	20·36	87·24
N: 50–211 ..	68·12	50·28	118·40	20·98	18·67	88·98
M. 423/41 ..	64·97	46·84	111·81	20·87	18·54	88·83
Co. 331	61·77	46·90	108·67	21·08	18·66	88·51
P.O.J. 2150 ..	55·69	46·91	102·60	21·22	18·08	85·20
Mean	66·02	48·93	114·95			
S.E.	±4·396	±4·270				
C. of V.	6·7%	8·7%				

TABLE 4*c*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE THIRD VARIETY TRIAL AT MIWANI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 680	74·25	43·40	117·65	19·76	17·09	86·48
Co. 331	65·01	47·11	112·12	20·15	17·02	84·46
Co. 1001	62·56	38·58	101·14	19·82	17·07	86·12
N: Co. 339 ..	60·51	45·33	105·84	20·76	17·81	85·78
M. 31/45	57·12	36·68	93·80	19·86	17·44	87·81
P.R. 905 ..	*	25·29	25·29	20·02	17·75	88·51
Mean	63·89	39·40	92·64	*Value Missing		
S.E.	±4·946	±6·060				
C. of V.	7·7%	15·4%				

The yield results of the first trial showed that the varieties were not statistically different. The mean cane yields show substantial average cane yield drop of 30 per cent and both Q. 47 and C.P. 29/291 showing yield decline of 25 per cent. There was negligible change in variety positions with regards to mean cane yields. However, it is noteworthy that Co. 331, has been convincingly outyielded by three varieties, Co. 746, N: Co. 293 and Q. 47. These data indicate that the three varieties could possibly replace Co. 331 if their present performance continues in the subsequent ratoons. All the varieties had good juice quality at harvest.

The non-significant yield differences in the varieties were also noted in the second trial. As in first trial, Co. 331, has been outyielded by Co. 440, Co. 467 and N: 50-211. All the varieties in the trial were of average juice quality at harvest. However, once again as was in plant crop performance, Co. 680, Co. 440, Co. 467, N: Co. 293 and N: 50-211. However, N: 50-211 has a multitude of thin stalks which lodge badly towards harvest.

All the varieties had mediocre juice quality which was inferior to that of the first and second trials presented above. The relatively much lower purities and higher brix values might be attributed to the fact that in this trial, these data were obtained from one sample only where variation is almost invariably high.

Three other 1st ratoon crop variety trials were harvested at Kimwani National Farm in the Songhor area of the Rift Valley Province in late April, 1971. The trial tested the yield performances of 18 varieties using three separate squares of 6×6 Latin Square design. The cane yield in tons/acre and the juice analyses for the three squares are summarized in Tables 5a, 5b and 5c.

TABLE 5*a*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE FIRST VARIETY TRIAL AT KIMWANI NATIONAL FARM

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 680	119·67	81·33	201·00	16·47	13·26	81·72
B. 47419 ..	108·48	61·54	170·02	16·84	13·58	82·43
Co. 421	104·75	82·98	187·73	16·95	14·00	82·53
N: Co. 339 ..	103·52	92·46	195·98	16·82	13·99	83·52
Q. 47	98·37	84·26	182·63	16·95	13·69	80·72
P.R. 905 ..	75·42	44·04	119·46	17·12	14·10	82·36
Mean	101·70	74·43	176·13			
S.E.	±5·905	±4·210	L.S.D.	5%	1%	0·1%
C. of V.	5·8%	5·6%		8·78	11·98	16·21

TABLE 5*b*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE SECOND VARIETY TRIAL AT KIMWANI NATIONAL FARM

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
B. 52298 ..	120·02	78·79	198·81	16·20	13·50	83·24
N: Co. 293 ..	113·27	89·30	202·57	16·19	13·20	81·52
Co. 434	102·55	71·33	173·88	16·26	13·33	81·96
H. 39–5803 ..	98·30	67·78	166·08	16·85	14·06	88·47
M. 31/45 ..	96·78	68·37	145·15	16·68	14·01	83·74
P.R. 980 ..	90·59	71·15	161·74	16·50	11·03	81·81
Mean	103·59	74·45	174·71			
S.E.	±13·966	±12·920				
C. of V.	13·5%	18·2%				

TABLE 5c—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE THIRD VARIETY AT KIMWANI NATIONAL FARM

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
B. 41227	127·10	65·07	192·17	16·83	14·04	75·14
N:Co. 334 ..	125·97	92·92	218·89	16·40	13·60	82·80
Q. 70	113·40	60·10	173·50	16·69	13·92	83·99
R.R. 1013 ..	98·54	79·12	177·66	16·25	13·44	82·67
Co. 449	97·82	70·62	186·44	16·74	14·00	83·69
P.O.J. 3150 ..	83·51	66·96	150·47	16·59	13·82	84·26
Mean	107·72	72·46	180·18			
S.E.	±12·92	±72·46	L.S.D.	5%	1%	0·1%
C. of V.	12·0%	±8·8%		13·25	18·07	24·45

The data show that in the first trial, N:Co. 339 significantly outyielded both P.R. 905 and B. 47419 and the rest of the varieties at 5 per cent level. Similarly, Q 47, Co 680 and Co. 421 all of which showed no significant differences among themselves, significantly outyielded P.R. 905 and B. 47419 at 0.1 per cent level. Nevertheless, a comparison of cane yields of plant and ratoon crops showed that all varieties experienced substantial yields reductions from plant crop to first ratoon crop. B 47419 had the highest while N.Co. 339 the least drop of 43 per cent and 10 per cent respectively. The combined cane yields of the two crops show that like in the plant crop results, Co. 680 had the best yields and was closely followed by N:Co. 339 and Q. 47. The substantial increase in the yield of Q. 47 may be partly attributed to the negligible wild pig damage which this variety experienced as against considerable damage it suffered in the plant crop. Similarly P.R. 905 was once again a "non-starter" as the plant crop. This was because it experienced severe mosaic in all the plots, which attack affected growth and yield at harvest.

All the varieties had poor juice quality partly due to heavy rains which occurred just before and during harvest, and partly due to excessive lodging which occurred in all the plots. The results of this trial indicate that both Co. 680 and N:Co. 339 are proving to be better than Co. 421; the commercial variety for the area.

Unlike the first trial, there were no significant differences between varietal means in the second trial. There was however, a significant yield decline from the plant crop to the first ratoon, with B. 52298 having the highest decline of 34 per cent. The small decline in cane demonstrated by N:Co. 393 indicated that this variety might be a better ratooner. M.31/45 suffered heavy damage from wild pig and hence its very low yield at harvest. Like in the first trial, all the varieties had poor juice quality owing to heavy rains during harvest coupled with excessive lodging.

In the third trial, N.Co. 334 outyielded B. 41227, Q. 70 and P.O.J. 3150 (P.Co. 001), Co. 449 at 1 per cent and P.R. 1013 at 5 per cent level respectively. Similarly P.R. 1013 significantly outyielded Q. 70 at 1 per cent level and both B. 41227 and 1st P.O.J. 3150 at 5 per cent level. A comparison of plant crop and 1st ratoon crop yields showed a mean cane yield decline of 32 per cent, with B. 41227 and Q. 70 suffering greater yield decline of 48 per cent and 47 per cent respectively.

The data from the three trials showed that N:Co. 339 in the first trial, N:Co. 293 in the second trial, and N:Co. 334 in the third trial were better ratooners than the rest of the 18 varieties tested, including Co. 421. The three varieties had the least yield decline.

Three more ratoon crop variety trials were harvested at Muhoroni in March, 1971. The trials compared the yield performances of 18 clones using three separate squares of a 6×6 Latin Square design. Tables 6a, 6b and 6c are a summary of mean cane yield and juice analyses of the three trials.

TABLE 6*a*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE FIRST VARIETY TRIAL AT MUHORONI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 746	65·51	50·78	116·29	22·19	19·84	89·40
Q. 47	65.09	50·04	115·13	23·68	20·86	88·09
M. 31/45	56·77	30·46	87·23	22·86	20·08	87·83
Co. 434	56·38	44·13	100·51	22·67	20·29	89·50
N:Co. 339 ..	53·01	41·97	94·98	23·97	20·92	87·27
Co. 421	50·89	45·01	95·90	23·25	19·86	85·41
Mean	57·94	43·73	101·67			
S.E.	±9·607	±7·760	L.S.D.		5%	
C. of V.	16·5%	17·7%			16·19	

TABLE 6*b*—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE SECOND VARIETY TRIAL AT MUHORONI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 1001	64·94	42·23	107·17	22·49	19·63	87·28
N. 50–211 ..	60·15	42·22	102·37	22·65	19·97	88·16
B. 47419	57·94	38·71	96·65	22·06	19·95	90·43
Co. 421	55·16	40·58	95·74	23·35	20·54	87·96
M. 423/41 ..	49·61	37·85	87·46	22·45	19·26	85·79
Co. 449	48·76	42·95	91·71	22·49	20·07	89·23
Mean	56·09	40·76	96·85			
S.E.	±6·46	±5·89				
C. of V.	11·5%	14·4%				

TABLE 6c—MEAN CANE YIELD IN TONS/ACRE AND JUICE ANALYSES OF PLANT AND 1ST RATOON CROPS OF THE THIRD VARIETY TRIAL AT MUHORONI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
Co. 467	59·06	43·68	102·70	23·46	20·82	88·74
Co. 680 ..	54·40	42·13	96·53	23·31	20·31	87·12
Co. 421	45·54	41·53	87·07	22·98	19·88	86·51
B. 52298	45·32	41·16	86·48	22·87	19·54	85·43
P.O.J. 3150 ..	35·59	38·48	74·07	23·08	20·06	86·91
H. 39–5803 ..	31·21	36·81	68·02	22·22	19·67	88·52
Mean	45·19	40·63	85·82			
S.E.	±7·08	±7·32				
C. of V.	15·7%	18·0%				

In the first trial, there were significant differences between varietal mean yields. Both Co. 746 and Q. 47 outyielded M.31/45 at 5 per cent level. However, the differences among remaining varieties were not significant. M.31/45 experienced a very substantial cane yield decrease being 46 per cent of the plant crop yield. This decline has little to do with varietal performance but of damage through theft. Similarly, Q. 47 suffered some damage through chewing by human. It is therefore likely that this variety could give higher cane yields if protected from the present damage. However, Co. 746 and Q. 47 have repeated their plant crop performance of being the highest cane yielders in the trial, and both varieties have convincingly beaten Co. 421, which is the present standard commercial clone for the area. The two varieties combine high mean cane yields with good juice quality, and therefore show promise as potential commercial varieties for the area.

While there were no statistically significant differences between varieties tested in trial 2, it was evident that both Co. 1001 and N: 50-211 had higher yields than Co. 421, the present standard commercial variety for the area. If these varieties continue to yield high, they could be considered for commercial cultivation in preference to the present variety. However, it should be noted that although N: 50-211 has given high mean cane yield, this variety tends to have thin stalks and lodges heavily. For this reason, it is doubtful whether farmers can readily accept it for commercial cultivation since its harvesting and handling could prove unpopular with the labour.

All the varieties had satisfactory juice quality at harvest.

In the third trial, also differences between varietal means were not significant. However Co. 467 and Co. 680 again outyielded Co. 421, the current standard commercial variety for the area. Also, as with the plant crop results, all the varieties in this trial have given relatively lower mean cane yields that the varieties in the first and second trials. However, all the varieties had better juice quality than those obtained in the plant crop.

The data obtained so far from the twelve different variety trials in the four main cane growing zones, Kibos, Miwani, Kimwani National Farm for the Chemelil-Songhor area, and Muhoroni for the Sugar Settlement area, suggest that several varieties, including Co. 746, Co. 680, Q. 47, Co. 440, N: 339 and N.Co. 293 have considerable potential as possible commercial varieties for the four main cane growing zones. These varieties have outyielded in both plant and first ratoon crops, Co. 421 and Co. 331, which are the only two standard commercial varieties in the area. Furthermore, a comparison of plant and first ratoon mean cane yield data in the twelve trials demonstrate that there is substantial cane yield decline in all the varieties tested. The mean cane yield decline range from 24 per cent to 38 per cent. This very large drop in yield is unexpected since the magnitude of drop in the yields of ratoons under

normal growing conditions reported by other countries is usually less than 20 per cent. This substantial decline in cane yield of the ratoons require some serious investigation to establish the real causes. Ratoon stunting disease has been suggested as a possible cause of this, but this has not been verified.

A second ratoon variety trial was harvested at Butere in September. The trial evaluated the yields of 6 varieties using a 6×6 Latin Square design. The mean cane yields in tons/acre of the three crops and juice analyses for the second ratoon are summarized in Table 7.

TABLE 7—MEAN CANE YIELD IN TONS/ACRE FOR THREE CROPS AND JUICE ANALYSES OF THE 2ND VARIETY TRIAL AT BUTERE

Variety	Cane Yield				Juice Analyses for 2nd Ratoon			
	Plant Crop	1st Ratoon	2nd Ratoon	Total	Brix	Pol	Purity	Fibre per cent of cane
H.32–1063..	40·3	42·1	52·0	134·4	19·2	11·5	90·5	12·1
B. 41227 ..	35·7	43·7	53·0	132·4	19·2	11·3	90·2	13·5
N:Co. 293..	49·4	38·0	42·1	129·5	20·4	11·8	89·1	12·5
Co. 205 ..	35·3	50·7	35·8	121·8	18·3	17·6	81·7	18·8
N: 50–211..	33·0	40·7	34·8	108·5	20·1	11·0	87·9	13·8
N:Co. 310..	33·7	26·0	32·6	92·3	20·8	12·5	89·2	11·4
Mean ..	37·9	40·2	41·7	119·8				
S.E. ..	±4·015	±2·860	±7·642					
C. of V. ..	18·3%	12·3%	18·3%					

Because of poor management, varietal differences could not be brought out, rather the variability due to other factors, obscured the performance of the varieties. The mean yields were unusual in that instead of the typical decline with age, there was a yield increase from plant crop to second ratoon. This confirms presence of extraneous factors other than varietal genetic potential.

A first ratoon variety trial under irrigation was harvested at Ramisi in October. The trial tested the yields of 8 varieties using three replicates of Randomized Block design. The mean cane yield in tonnes/hectare of the plant and first ratoon crop are presented in Table 8.

TABLE 8—MEAN CANE YIELD IN TONNES/HECTARE AND JUICE ANALYSES OF THE VARIETY TRIAL UNDER IRRIGATION AT RAMISI

Variety	Cane Yield			1st Ratoon Brix	1st Ratoon Pol	1st Ratoon Purity
	Plant Crop	1st Ratoon	Total			
B. 41227 ..	144·53	99·71	214·24	19·88	17·77	89·64
N:Co. 334 ..	114·71	88·26	202·97	19·85	17·62	89·59
N:Co. 376 ..	107·83	87·16	194·99	19·68	17·74	89·00
Co. 421	102·01	86·06	188·07	19·78	17·66	89·73
N:Co. 310 ..	101·13	78·24	179·37	19·82	17·60	89·04
Co. 775	82·63	71·82	154·45	19·74	17·66	89·23
N. 10	87·55	62·27	149·82	19·87	17·64	89·24
CP. 29/305 ..	59·84	61·59	121·43	19·75	19·82	89·01
Mean	96·27	79·38	175·66			
S.E.	±19·21	±17·49	L.S.D.	5%	1%	
C. of V.	19·9%			21·65	30·05	

The variance analysis of cane yield for the first ratoon crop showed that no significant differences existed among the top five varieties. However, B. 41227 significantly outyielded N. 10 and C.P. 29/305 at 1 per cent level, while N. Co. 334, N:Co. 376 and Co. 421 outyielded the two varieties at 5 per cent level of probability. A combined plant and first ratoon mean yield data showed that B. 41227 was more responsive to irrigation than the other varieties tested. This corroborates the fact that this variety performs better under irrigation than under rainfall conditions. All the varieties had good juice quality.

However, the cane yield level was low for an irrigated crop. This is related to the fact that irrigation was not given regularly, because of lack of adequate supervision. Despite poor management, the data indicate that there is considerable potential for improving yields under irrigation with varieties like B. 41227, N:Co. 334 and N:Co. 376.

Fertilizer Trials

A second ratoon Rates and Methods of Nitrogen Application Trial was harvested at Gazi in May 1970. The trial tested 9 different combinations of rates and methods of nitrogen application using 4 replicates of a randomized block design. All the nitrogen was applied in the form of Sulphate of Ammonia, and Co. 775 was used as the test variety. The combinations tested were: Nil vs 62.5 Kg/ha in the planting furrow vs 125 Kg/ha in the planting furrow vs 250 Kg/ha in the planting furrow vs 375 Kg/ha in the planting furrow vs Nil in the planting furrow plus 375 Kg/ha topdressed in two equal increments vs 62.5 Kg/ha in the planting furrow plus 312.5 Kg/ha topdressed in two equal increments vs 125 Kg/ha in the planting furrow plus 250 Kg/ha topdressed in one increment vs 250 Kg/ha in the planting furrow plus 125 Kg/ha topdressed in one increment.

The mean cane yields in tonnes/hectare for the three crops are given in Table 9.

Table 9—Mean Cane Yield in Tonnes/Hectare of the Rates and Methods of Nitrogen Application Trial at Gazi

Treatments	Cane Yield			Total
	Plant Crop	1st Ratoon	2nd Ratoon	
1. Nil in the planting furrow plus 375 Kg./ha. topdressed in two equal increments ..	90·71	46·94	86·67	224·32
2. 62·5 Kg./ha. in the planting furrow plus 312·5 Kg./ha. topdressed in two equal increments	99·32	47·92	75·50	222·74
3. 125 Kg./ha. in the planting furrow plus 250 Kg./ha. topdressed in one increment..	84·36	48·28	74·75	207·39
4. 250 Kg./ha. in the planting furrow plus 125 Kg./ha. topdressed in one increment..	82·45	49·16	64·11	195·72
5. Control—Nil application	82·15	40·95	66·08	189·18
6. 125 Kg./ha. in the planting furrow ..	91·06	39·98	56·22	187·83
7. 375 Kg./ha. in the planting furrow ..	82·60	40·97	60·26	183·83
8. 250 Kg./ha. in the planting furrow ..	76·00	41·16	63·22	180·38
9. 62·5 Kg./ha in the planting furrow	67·22	36·50	51·52	155·24
Mean	69·05	43·54	66·48	179·07
S.E.	14·17	13·41	19·13	
C. of V.	6·0%	7·8%	13·7%	

The plant crop results of this trial showed that the differences between the nitrogen applied in the planting furrow and topdressing were not statistically significant. However, the treatment means indicated that topdressing was better than placing nitrogen in the planting furrow.

Unfortunately, the first ratoon data were obtained from immature crop following an accidental fire which forced the trial to be harvested at 10 months stage. Nevertheless, it is interesting to note that those treatments which received further topdressing in the first ratoon produced higher cane yields than those without. Similar results were obtained in the first ratoon crop, where substantial response to topdressing is evident.

These data suggest that topdressing nitrogen is more effective in increasing cane yields than applying it in the planting furrow.

Cane Quality Study

Cane quality at Miwani

A study of the quality of cane supplied to Miwani Sugar Mills was conducted in October, 1970. The study compared the quality of the two major commercial varieties, Co. 331 and Co. 421. At maturity, Co. 331 is known to have excessive proportion of late suckers or "water-shoots" which are suspected to seriously reduce the recovery of *crystal* sugar per ton of cane.

As there were no facilities for the direct analysis of cane for brix, pol or fibre, indirect methods were resorted to. The prepared cane was analysed for moisture, samples of one kilogramme being dried to constant weight in duplicate on the Khainovsly type of bagasse drier used at Miwani. The first expressed juice was analysed for brix and pol by standard methods.

Extensive studies in Queensland have indicated that the brix of absolute juice may be taken to be related to the brix of the first expressed juice by the factor 0.95, that is, $b_a = 0.95\ b_j$. The applicability of this factor in Kenya has not been tested, but it is known to apply in many countries outside Australia, and, from the very nature of sugar-cane, it cannot be very wide off the mark. Given the brix of absolute juice, ba, and water per cent cane, wc, it is possible to calculate brix per cent cane, bc, by the formula:—

$$b_c = w_c \times \frac{b_a}{100 - b_a}$$

Then, from b_c and w_c it is possible to determine fibre in cane, f_c thus:

$$f_c = 100 - b_c - w_c$$

Tests were carried on successive week days over a period of three weeks, fibre in cane being calculated by use of the above formulae. The average results for the three individual weeks and the overall period are shown in Tables 10a and 10b.

Table 10*a*—Juice Analyses of Variety Co. 331 at Miwani Sugar Mills Ltd.

Week	Crusher Juice			Cane	
	Brix	Pol	Purity	Moisture	Fibre
1	17·4	15·1	86·7	70·8	15·3
2	18·0	15·3	84·8	71·1	14·3
3	17·0	15·4	87·0	70·8	15·3
Mean ..	17·5	15·3	86·2		15·0

TABLE 10*b*—JUICE ANALYSES OF VARIETY CO. 421 AT MIWANI SUGAR MILLS LTD.

Week	Crusher Juice			Cane	
	Brix	Pol	Purity	Moisture	Fibre
1	20·0	17·6	88·0	68·3	15·7
2	18·6	16·4	87·8	70·6	14·2
3	20·2	18·2	90·3	67·0	17·1
Mean ..	19·6	17·4	88·7	68·3	15·7

TABLE 11—JUICE ANALYSES OF VARIETY CO. 421 AT MUHORONI

Week	Crusher Juice			Cane	
	Brix	Pol	Purity	Moisture	Fibre
1	19·3	17·3	89·4	—	—
2	19·4	17·2	87·7	67·0	17·9
3	19·1	16·8	87·9	69·8	16·4
4	17·9	15·7	87·5	69·6	16·4
Mean ..	18·9	16·7	88·1	68·8	16·9

A scrutiny of the results of the juice analyses for the two varieties indicates that juice of Co. 421 was superior to that of Co. 331 in respect of all three measured traits, brix, pol and purity. With regard to fibre it is noted that Co. 421 yielded a slightly higher result than Co. 331 over all. The observed differences of 0.4 and 0.1 in the first two weeks are within the limits of accuracy of determination. However, the difference of 1.8 in the third week is too large to be attributable to errors of sampling or analysis. Consequently, these results are consistent with the observed presence of immature stalks or "water-shoots" in Co. 331. Thus the data indicate that mature Co. 331 have a higher fibre than Co. 421 and that both canes contain a very high proportion of fibre when overmature.

Phosphate in juices

Two investigations were conducted to determine the levels of phosphate in raw juices at Miwani and Muhoroni Factories. Conflicting reports had been received regarding the levels of phosphate in the raw juices at Chemlil and Muhoroni Factories. The Chemelil Factory reported high phosphate levels while Muhoroni claimed low levels and phospheric acid had to be added to the mixed juice from time to time to assist clarification. Not much was known of phosphate levels, but they were believed to be adequate. These disparities were considered worthy of investigation.

Phosphate levels in juices at Miwani

Phosphate determinations were carried out using a spectrophotometer at the Miwani Factory in accordance with a procedure specified by the Bureau of Sugar Experiment Stations, Queensland. Test juices were filtered, diluted and subjected to the same colour development as the standard solutions. First expressed and mixed juices were tested at a dilution of 1 in 200 clarified juice was tested optionally at 1 in 200 or 1 in 100. The results are presented in Table 12.

TABLE 12—PHOSPHATE LEVELS OF CANE JUICES AT MIWANI FACTORY

Type of juice	Level of P_2O_5	Level P
First Expressed Juice (Composite)..	460 ppm	202 ppm
Mixed Juice (Composite)	300 ppm	132 ppm
Clarified Juice (Snap)	160 ppm	70 ppm
Clarified Juice (Snap)	150 ppm	66 ppm

Phosphate levels in juices at Muhoroni

A second phosphate determination trial was carried out at Muhoroni Factory using a method developed and used by the Mauritius Sugar Industry Research Institute in which the colour of the juices is matched against the colours of standard solutions. The method uses Ammonium Molybdate and Ascorbic Acid. The test on multiple samples of various juices yielded the following results presented in Table 13.

TABLE 13—PHOSPHATE LEVELS OF CANE JUICES AT MUHORONI FACTORY

Type of juice	Level of P_2O_5	Level P
First Expressed Juice	437 ppm	191 ppm
Mixed Juice	350 ppm	154 ppm
Clarified Juice	50 ppm	22 ppm

The data from the two factories, Miwani and Muhoroni, indicate that there are abnormally high levels in the juices tested. This corroborate the reports from the Chemelil Factory where the procedures used for phosphate determinations have been checked and verified by the chemists there.

A scrutiny of reported low levels of phosphate in the juice at Muhoroni were traced to a fault in analytical procedure. The data therefore have now established that conditions at Muhoroni are much the same as at the other two factories.

However, since phosphate content of the juice reflects the availability of phosphate in the soil, these data point to the fact that the level of available phosphate in the sugar soils tested is high, and this may partly account for the reported lack of phosphatic fertilizers.

Furthermore, the high level of residual phosphate detected in the clarified juice at Miwani suggests that there is room for a check on clarification procedure there.

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S. B. OBURA,
Senior Sugar Research Officer.

Appendix I—Rainfall in MM at Selected Stations—1970

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1970	Total 1969
Nyanza Province														
National Sugar Research Station Kibos	286·0	101	186	284	178	122	18	145	44	100	109	117	1,690	1,148
Cotton Research Station, Kibos	222·0	123·1	154·0	274·2	140·5	52·4	11·7	109·8	51·8	38·1	97·9	76·9	1,352·4	911
Miwani Section I	216·3	55·7	170·4	170·4	96·8	79·5	38·9	131·1	50·0	97·3	119·9	133·0	1,306·3	1,119
Miwani Section II	219·1	55·9	155·9	177·8	123·1	81·8	45·0	105·6	82·6	60·7	51·9	96·0	1,255·4	1,108
Miwani Mills	236·3	67·3	173·3	195·0	113·7	127·0	59·7	109·0	109·1	40·6	62·1	158·4	1,451·5	1,242
Kibigori C.A.C. Estate	144·6	30·1	213·8	209·6	130·4	115·6	39·7	94·8	7·9	62·7	92·2	127·3	1,268·7	1,150
Chemelil Sugar Co. Workshop	171·0	60·9	225·0	189·2	150·6	170·3	64·7	115·6	86·4	75·3	54·9	120·5	1,484·4	1,416
Chemelil Mill	212·9	57·9	221·3	196·0	166·6	190·0	92·5	79·2	115·6	145·8	81·0	115·1	1,673·9	1,484
Tamu Settlement	306·	142	351	201	192	110	168	128	97	89	49	136	1,969	1,782
Nyando Sugar Estate	205·7	67·6	191·8	135·6	129·5	72·4	84·3	98·0	75·2	90·7	24·5	124·5	1,299·8	828
Western Province														
Research Station Kakamega	140·0	125·8	250·7	273·1	218·2	148·4	218·9	303·4	208·7	68·5	105·7	50·7	2,012·1	1,841
Mumias Boma	327	65	327	321	201	79	101	162	116	145	4	50	1,898	1,871
Butere Health Centre	200	103	421	446	267	144	101	279	135	24	4	41	2,165	1,950
Rift Valley Province														
Mberere Estate	275·3	29·5	194·6	153·9	84·1	89·7	71·9	170·7	135·4	55·1	89·9	55·6	1,405·7	1,368
Kimwani National Farm	230·3	51·3	178·2	177·3	120·7	75·9	70·7	73·7	71·9	76·2	112·0	73·9	1,312·1	1,859
Thessalia Farm	266·7	73·1	268·7	218·9	158·1	99·4	112·3	109·5	114·3	122·4	34·8	189·0	1,767·2	1,291
Coast Province														
Gazi	25·4	—	54·9	305·5	305·0	106·1	56·6	25·9	16·5	7·6	38·0	40·0	981·5	937
Ramisi	64·2	—	76·2	328·6	383·8	89·0	71·7	61·9	59·9	6·0	32·0	97·3	1,271·5	1,108

Appendix 2—List of Selections in the E.A. '69 Series Second Year Seedling Trial

Cross No.	Parentage	Variety No
110	CP. 3479 x Co. 449 (1)	E.A. 69–48
91	NCo. 349 x Co. 356 (4)	E.A. 69–59
90	POJ. 2725 x Co. 331 (2)	E.A. 69–57
90	POJ. 2725 x Co. 331 (1)	E.A. 69–56
87	Bo. 10 MP (2)	E.A. 69–35
85A	CP. 44–101 MP (9)	E.A. 69–54
85A	CP. 44–101 MP (6)	E.A. 69–51
24	Co. 421 x N 50–123 (3)	E.A. 69–38
88	Co. 718 x CP. 44–101 (2)	E.A. 69–43
24	Co. 421 x N 50–123 (1)	E.A. 69–36
113	Co. 779 x PR. 975 (1)	E.A. 69–44
88	Co. 718 x 44–101 (1)	E.A. 69–42
85A	CP. 44–101 MP (2)	E.A. 69–50
85A	CP. 44–101 MP (8)	E.A. 69–53
114	N. 10 MP (2)	E.A. 69–55
24	Co. 421 x N 50–123 (2)	E.A. 69–37
85A	CP. 44–101 MP. (1)	E.A. 69–49
102	Co. 765 MP (1)	E.A. 69–45
119	NCo. 376 MP. (1)	E.A. 69–60
24	Co. 421 x N 50–123 (4)	E.A. 69–89
85A	CP. 44–101 MP. (7)	E.A. 69–52
111	Co. 464 MP. (2)	E.A. 69–40
111	Co. 464 MP. (3)	E.A. 69–41
53	NCo. 382 MP.	E.A. 69–61
116	Co. 798 MP. (1)	E.A. 69–46
936	PR. 100 x EROS (1)	E.A. 69–58
116	Co. 798 MP. (3)	E.A. 69–47

Appendix 3—List of Crosses of the Selections in the E.A. '70 Series in Multiplication Plots at Kibos

Cross No.	Cross No.	Cross No.	Cross No.
50 (7)	125 (2)	157 (3)	183 (1)
157 (1)	196/200/208 (1)	139 (2)	41 (1)
185A (1)	196 (1)	58 (1)	74 (1)
58 (1)	130 (3)	185A (2)	17 (3)
139 (5)	17 (1)	139 (3)	62 (5)
139 (1)	(3)	52 (7)	65 (10)
192 (1)	62 (4)	19 (1)	130 (5)
168 (3)	208 (1)	19 (4)	125 (5)
157 (1)	124B (1)	66 (4)	52 (6)
52 (4)	147 (4)	56 (9)	147 (4)
56 (11)	130 (1)	168 (1)	130 (4)
56 (6)	62 (1)	16 (1)	181 (2)
174 (1)	82 (6)	168 (2)	87 (6)
82 (5)	74 (4)	56 (1)	130 (11)
125 (5)	81 (5)	168 (5)	89 (2)
130 (10)	66 (1)	17 (5)	9 (3)
81 (6)	130 (7)	168 (6)	56 (2)
130 (8)	87 (6)	81 (7)	186 (1)
157 (2)	186 (1)	124B (1)	135/125/196/208 (1)
96 (1)	62 (3)	147 (2)	190 (1)
9 (2)	9 (4)	47 (3)	25 (4)
52 (3)	190/124 (1)	147 (1)	186/180 (1)

APPENDIX 3—LIST OF CROSSES OF THE SELECTIONS IN THE E.A. '70 SERIES IN MULTIPLICATION PLOTS AT KIBOS—(*Contd.*)

CROSS NO.	CROSS NO.	CROSS NO.	CROSS NO.
47 (1)	81 (4)	130 (9)	190/124 (2)
50 (1)	125 (13)	74 (4)	65 (12)
87 (4)	125 (1)	47 (2)	81 (11)
17 (2)	147 (3)	56 (4)	52 (5)
74 (3)	81 (9)	12 (1)	50 (4)
74 (1)	125 (4)	50 (2)	25 (7)
147 (5)	130 (6)	9 (1)	81 (8)
80 (2)	65 (18)	80 (4)	50 (6)
74 (2)	196 (2)	125 (2)	81 (4)
56 (8)	96 (2)	125 (12)	72 (1)
125 (11)	56 (5)	9 (1)	125 (5)
130 (2)	56 (4)	56 (7)	96 (3)
125 (8)	65 (15)	181 (1)	19 (2)
9 (2)	50 (5)	181 (1)	19 (3)
125 (3)	150 (3)	87 (3)	89 (1)
65 (13)	41 (2)	14 (7)	19 (5)

APPENDIX 4—LIST OF CROSSES IN THE 1ST YEAR SEEDLING TRIAL OF E.A. 1971 SERIES

Cross Number	Parentage	Year of crossing	No. of seedlings in the cross
3A	B. 42231 M.P.	1968	590
31	B. 42231 M.P.	„	20
5	B. 59104 x B. 3337	1969	90
104	B.O. 29 M.P.	1968	1,174
284	Co. 349 x Co. 1001	„	73
37	Co. 349 x C.P. 44–101	1969	10
109	Co. 404 x B.O. 14	1968	177
189	Co. 404 x N.Co. 310	„	220
173	Co. 419 M.P.	„	642
75	Co. 421 x B. 42231	„	354
79	Co. 421 x C.P. 29–116	1969	590
113	Co. 421 x H. 39–7028	„	90
107	Co. 421 x Mex 53–142	„	130
140	Co. 421 M.P.	„	777
126	Co. 440 M.P.	1968	2,364
7	Co. 602 M.P.	„	1,132
47	Co. 617 M.P.	„	736
48	Co. 622 M.P.	„	1,150
288	Co. 677 x B. 4681	„	56
285	Co. 677 x B. 60163	„	583
216	Co. 677 x Eros	„	519
289	Co. 677 x CoK 30	„	1,470
240	Co. 677 x N. 50–93	„	241
238	Co. 718 x P.O.J. 2822	„	47
150	Co. 740 x Co. 775	„	617
103	Co. 765 M.P.	„	260
23	Co. 775 x D. 109	„	155
106	Co. 779 x Q. 47	1969	29
251	Co. 779 x Eros	1968	1,082
85	Co. 779 x Q. 47..	1969	499
83	Co. 810 x Mex 53–142	„	240
131	Co. 967 M.P.	1968	416
148	Co. 976 x Co. 775	„	360

APPENDIX 4—LIST OF CROSSES IN THE 1ST YEAR SEEDLING TRIAL OF E.A. 1971—(*Contd.*)

Cross Number	Parentage	Year of crossing	No. of seedlings in the cross
260	Co. 976 x N. 52–219	„	860
242	Co. 976 x P.O.J. 2822	„	18
59	C.P. 34–79 x B. 42231	„	90
44	C.P. 34–79 x Co. 312	„	210
115	C.P. 34–79 x N.Co. 310	„	21
19	C.P. 34–120 x N. 50–211	„	34
29	C.P. 36–111 M.P.	„	870
6	C.P. 52–68 x B. 3337	1969	792
248	C.P. 52–68 x B. 4681	1968	380
243	C.P. 52–68 x Co. 775	„	936
217	C.P. 52–68 x Eros	„	531
8	C.P. 52–68 x N. 52–219	„	180
7	C.P. 52–68 x N. CO. 310	„	1,132
194	Ebene 1/37 x B. 42231	1968	172
156	Ebene 1/37 x Co. 953	„	193
91	E. 50/47 M.P.	„	137
4	E. 50/47 M.P.	1969	410
145	H. 39–3633 x Co. 775	1968	1,100
164	H. 39–3633 x H. 39–7028	„	393
258	H. 46–2405 x Q. 47	„	170
78	L. 60–14 M.P.	„	77
247	L. 60–40 x B. 3337	1968	365
111	MYZ 151 x Co. 945	„	290
138	MYZ 151 x Eros	„	600
8	N. 50–93 M.P.	„	180
6	N. 50–211 M.P.	„	800
2	N. 52–219 M.P.	1969	890
54	N. 52–219 M.P.	1968	202
159	N. Co. 79 x Co. 453	„	356
39	N:Co. 79 x C.P. 29–116	1969	50
154	N:Co. 79 x Mex 53–142	1968	72
149	N:Co. 79 x Pepe Cauca	„	167
137	N:Co. 79 x PR. 905	„	211
141	N:Co. 292 x B. 42231	„	1,065
97	N:Co. 292 x Co. 312	„	1,727
282	N:Co. 292 x Co. 419	„	1,430
36	N:Co. 293 M.P.	„	820
2	N:Co. 293 x N: 50–123	„	890
1	N:Co. 310 M.P.	1969	20
267	N:Co. 339 x B. 4681	1968	137
11	N:Co. 339 x C.P. 44–101	1969	390
272	N:Co. 349 x B. 60163	1968	169
129	N:Co. 349 x Co. 312	„	800
35	N:Co. 349 x C.P. 44–101	„	640
254	N:Co. 349 x M. 147/44	„	166
49	N:Co. 349 M.P.	„	376
179	N:Co. 376 x Co. 453	„	382
153	N:Co. 376 x C.P. 29–305	„	3
271	N:Co. 376 x M. 147/44	„	517
29	P.O.J. 2725 x B. 3337	1969	70
122	P.O.J. 2725 x B. 42231	1968	137
31	P.O.J. 2725 x Co. 356	1969	20
16	P.O.J. 2725 x Eros	1969	100
39	P.O.J. 2725 x H. 39–7028	1968	50
167	P.O.J. 2725 x Mex 53–142	„	124
68	P.O.J. 2725 M.P.	„	71
25	P.O.J. 2725 x N. 50–211	„	20
136	P.O.J. 2725 x Q. 47	„	393

APPENDIX 4—LIST OF CROSSES IN THE 1ST YEAR SEEDLING TRIAL OF E.A. 1971—(*Contd.*)

Cross Number	Parentage	Year of crossing	No. of seedlings in the cross
279	P.O.J. 3142 x B. 60163	1968	46
245	PR. 980 x 147/44	„	230
20	P.R. 1000 x B. 3337	„	539
60	P.R. 1000 x B. 42231	„	235
26	P.R. 1000 x B.O. 14	„	736
57	P.R. 1000 x Co. 312	„	2,966
146	P.R. 1000 x Co. 775	„	2,577
108	P.R. 1000 x C.P. 29–291	„	1,220
143	P.R. 1000 x C.P. 34–120	„	136
98	P.R. 1000 x C.P. 44–101	„	670
162	P.R. 1000 x H. 37–1933	„	1,435
118	P.R. 1000 x N: 50–93	„	330
94	P.R. 1000 x N: 50–123	„	470
121	P.R. 1000 x N:Co. 293	„	952
66	P.R. 1007 x Co. 301	„	8
84	P.R. 1007 x C.P. 29–116	1969	20
255	Trojan x C 617	1968	353
224	Trojan x Q 47	„	275
266	P.R. 1007 x N: 52–219	„	320

APPENDIX 5*a*—LIST OF VARIETIES IN SMUT BLOCKS IN NYANZA IN 1970

B. 39254	B. 4425	B. 4466	B. 45154
B. 4681	B. 47386	B. 4906	B. 50210
B. 51116	B. 51131	B. 51321	B. 52107
B. 52158	B. 52313	B. 5490	B. 54152
B. 49224	B. 57133	B. 57141	B. 57150
B. 5780	B. 58320	B. 60191	B. 60321
B.O. 29	C.B. 40–60	C.B. 40–77	C.B. 47–15
C.P. 36/105	C.P. 60/23	C.P. 61/37	C.P. 61/39
CO. 244	CO. 285	CO. 527	CO. 677
CO. 758	CO. 842	CO. 945	CO. 961
CO. 967	CO. 976	CO. 1007	COK. 30
COS. 109	D. 37/45	D. 141/46	D. 38/57
D. 42/58	E. 50/47	E. 141	H.M. 645
H.M. 661	L. 60–25	L. 60–40	L. 61–67
M. 134/32	M. 129/43	M. 202/46	M. 93/48
M. 409/51	M. 81/52	M. 442/51	M. 13/53
Mex 52/29	Mex 54/245	Mex 57/197	N. 51/168
N. 52/219	N. 53/216	N:Co. 291	P.O.J. 2447
P.O.J. 3067	P.T. 43–52	Q. 45	N:Co. 79

APPENDIX 5*b*—LIST OF VARIETIES IN SMUT BLOCKS AT MUMIAS IN 1970

B. 4681	B. 47258	B. 4906	B. 50210
B. 51116	B. 51131	B. 52107	B. 52158
B. 52313	B. 5490	B. 54142	B. 57150
B. 5780	B. 58320	B. 60191	B. 60321
B.O. 29	C.B. 40–69	C.B. 40–77	C.B. 47–15
C.P. 61/37	C.P. 61/39	CO. 244	CO. 285
CO. 527	CO. 677	CO. 842	CO. 945
CO. 961	CO. 976	COK 30	COS. 109
D. 42/58	E. 141	H.M. 645	L. 60–25
L. 61–67	M. 202/46	M. 423/51	M. 442/51
M. 81/52	M. 13/53	Mex 52/29	Mex 54/245
N. 51/168	N. 52/219	N. 53/216	N:CO. 291
P.O.J. 2747	P.O.J. 3067	Q. 45	CO. 758

APPENDIX 5*c*—LIST OF VARIETIES IN SMUT BLOCKS AT THE COAST IN 1970

B. 39250	B. 39254	B. 45154	B. 4906
B. 54142	B. 5780	B. 60163	B. 60191
B. 60321	E. 50/47	E. 141	M. 202/46
N. 51/168	M. 13/53		

COAST AGRICULTURAL RESEARCH STATION, MTWAPA

A.—Weather

Rainfall and weather data for Mtwapa and its main substations in the province are given in Appendix A.

Rainfall for Mtwapa was 354.4 mms below the 1969 figure, and 589.8 mms below the 10 years (1960-69) mean of 1329.4 mms. This pattern was much the same for other areas in the province. The low rainfall appeared to be much worse than in fact it was coming after three exceptionally wet years in 1966-68, which had resulted in higher than normal stocking rates in the livestock areas of the province. Appreciable rain did not fall at Mtwapa until April 20th, and it was during this month and May that 59.4 per cent of the annual rainfall was recorded. From June onwards the highest individual days record of rainfall was 26mms on December 6th. In the 7 months from June to December there were 84 days with rain, but of this total, only on 14 days were over 5mms of rain recorded. The short rains were a total failure in most areas. This resulted in a gradual drying up of the province as the year progressed, and this together with the dry start to 1971 created most serious grazing shortages and poor food crop yields. In contrast the year ended on a high note, the dry conditions being favourable to a very good cashew harvest of excellent quality.

B.—Reports on Experiments

VEGETABLES—W. P. Nyambu

Tomato Variety Trial

Results are given in Table I of a tomato variety trial conducted at Mtwapa during the long rains 1970:—

TABLE I—YIELDS OF SALEABLE FRUIT IN KGS/HECTARES

Order	Variety	Yield in Kgs/Hectare	Returns per Hectare @ 60 cts/Kg.	Estimates cost of Production per Hectare	Profit per Hectare
			K.Sh.	*K.Sh.*	*Sh.*
1.	Supermarmande ..	97,094	58,256.40	10,345.00	47,680.00
2.	Beauty..	88,376	53,025.60	10,345.00	42,680.00
3.	Money marker ..	86,667	52,000.20	10,345.00	41,655.00
4.	Best of All	70,114	42,068.40	10,345.00	31,723.00
	Means	85,563	51,337.80	10,345.00	40,992.80

Yield differences were not significant. The varieties tested had proved superior in an earlier screening trial consisting of over 10 varieties. Variety Best of All gave the highest yield in that trial and was recommended. In this trial however, it gave the lowest yield. Since yield differences were not significant, varieties Supermarmande, Beauty and Money Maker may be included in the list of those recommended for the fresh fruit market.

Apart from providing variety recommendations the trial indicates the potential of tomatoes as a cash crop for the sandy soils of the Coast Province where the ever present underground water can be made available through boreholes for irrigation.

Tomato "Virus Condition" Studies

During the year an attempt was made to control a "disease" on tomatoes causing wrinkling of the leaves, and stunting (temporarily referred to as "virus condition") by applying control measures on suspect vectors of the disease, Nematodes and Tobacco whitefly. The virus condition had been noted as serious in proceeding years at Mtwapa.

Details of treatments and results are given in Table II.

TABLE II—TOMATO VIRUS CONDITION STUDIES

TABLE II—*(Contd.)*

Spraying Treatments	Number of Plants per plot	Number of Plants affected per per plot Fumi- gated	Non-Fumi gated	Percentage "Virus" infection per plot Fumigated	Non-Fumigated	Percentage infection per spraying Treatment	Yield of fruit per spraying Treatment per Hectare (Kgs.)
Endosulfan + M45/ alternate/Zineb ..	8	0 · 0		0·0	0·0	0·00	48,755,77
Malathion + M45/ alternate/Zineb ..	8	1·2		12·5	25·0	14·75	38,478·00
M45/alternate/Zineb only	8	5·0		62·5	0·0	31·25	44,493,27
Control..	8	7·2		87·	25·0	56·25	37,181,70
TOTALS ..	32	13·4		162·5	50·0	106·25	168,908,74
Means	8	3·25		40·63	12·5	26·57	42,227,19

Results as shown in Table II indicate that the control of Tobacco whiteflies on tomatoes decreased the effect of the "Virus Condition" especially when Endosulfan was used. This suggests that the "disease" may be introduced and transmitted among tomato plants by the insect pest.

The control of nematodes on the other hand (with methyl bromide) increased the effect of the "Virus Condition" on plants which were not treated against tobacco whitefly. The reason for this may be the removal of nematode barners in vector-unprotected plants, resulting in easier introduction and free translocation of the "Virus Condition" pathogen in the plant sap. It may be inferred, therefore, that nematodes do not transmit this disease.

The use of Endosulfan to control tobacco whitefly and hence the "Virus Condition" on tomatoes has been recommended on the basis of this work. The same has been recommended previously for control of American Boll Worm on the same crop.

Sweet Pepper Trial

Table III shows the results of a sweet pepper variety trial conducted at Matuga during the Short Rains 1969/Long Rains 1970:—

TABLE III—SWEET PEPPER YIELD OF SALEABLE FRUIT IN TONNES/HECTARE

Variety	*Yield/Hectare (Tonnes)*
Chinese Giant	11·53
Yolo Wonder	8·42
Sweet Neapoletan	7·99
Mean	9·31
Last significant differences 5%..	1·67
1%..	3·86
Coefficient of Variation	5·1 per cent

Variety Chinese Giant gave significantly higher yields (p=0.05) than either Yolo Wonder or Sweet Neapolitan.

Consideration of market preferences for these varieties revealed that the bell-shape varieties were more in demand and attracted higher prices. Chinese Giant and Yolo Wonder belong to this group. Chinese Giant, however, appeared superior in this aspect. It was more bell-shaped, uniform and had a very glossy green colour when ready for the market. This variety gave a minimum estimated profit of Sh. 1,848 with a mean yield of approximately 11.5 tonnes per hectare—23 per cent higher than the second best variety.

Mildew and a disease tentatively called "Virus Condition" were observed rather late in the life of the trial and yields could have been higher.

Variety Chinese Giant is recommended for commercial cultivation.

Bulb Onion Variety Trial

A bulb onion variety trial planted at Mtwapa during Long Rains 1970 gave results as shown in Table IV.

TABLE IV—BULB ONIONS, GRADE AND TOTAL YIELDS IN KGS. PER HECTARE

	VARIETY	YIELD			
	Range Nos. Significance (highest yield to lowest)	Grade I diameter more than $1\frac{3}{4}''$ (43·75mms)	Grade II diameter $1–1\frac{3}{4}''$ (25–43·75mms)	Grade III diameter less than 1″ (25mms)	Totals (All Grades)
Texas Grano	5	11,096·65	7,595·49	202,255·55	18,894·69
Tropical Hybrid	4	4,049·62	6,623·65	173·61	10,846·88
White Creole	3	2,531·83	7,841·44	477·43	10,850·70
Red Creole	2	2,285·88	8,318·87	303·82	10,908·57
Bombay Red		1,200·81	1,388·89	173·61	2,763·31
Mean		4,169·56	6,354·17	266·20	10,792·83
Duncan's multiple Range Significant Differences:—					
5%	5	3,153·94	2,329·28	188·08	4,065·40
	4	3,096·07	2,285·88	188·05	4,007·53
	3	3,009·26	2,228·01	188·08	3,906·25
	2	2,879·05	2,126·74	173·61	3,3732·64
1%	5	4,369·21	3,226·27	274·88	5,656·83
	4	4,282·41	3,108·40	260·42	5,555·56
	3	4,181·14	3,081·60	260·42	5,410·88
	2	4,007·53	2,951·30	245·95	5,193·87
Coefficient of variation	—	39·10	18·9	36·84	19·57

Yield of 14 tonnes per hectare (bulb onions) is considered to be of marginal profit commercially. Results of this trial, therefore, reveal that bulb onions can be grown profitably in the wind blown sands of the coastal strip.

As rainfall cannot be relied upon irrigation water is necessary. 1970 was a dry year and on the whole the irrigation water applied was not sufficient for optimum growth.

Fusarium wilt was observed on all the varieties included in the trial. Bombay red was almost completely destroyed by the disease. Texas Grano was among the more resistant varieties.

A few seedlings transplanted at below pencil-thickness produced dwarfed bulbs in all varieties.

Variety Texas Grano was (in addition to Fusarium resistance) significantly better than the other varieties in overall yields. It is suggested that this variety be recommended for the coastal strip.

Dry Beans Variety Trial

This trial conducted at Wundanyi during the short rains of 1970 gave the results as shown in Table V.

TABLE V—DRY BEAN YIELDS KGS./HECTARE

Order	Variety	Range Nos.	Yield/hectare (Kgs.)
1	Kisangi (Local)	4	2,884·61
2	Marage (Local	3	2,756·41
3	Mexican 142	2	2,136·75
4	Merlohi-Italian		1,495·73
	Mean		2,307·69
Duncan's Multiple Range Significant figures	5%	4	275·64
		3	271·37
		2	262·82
	1%	4	418·80
		3	414·53
		2	397·44
Coefficient of Variation			6·57 per cent

From the data in Table V the local varieties of dry beans (Kisangi and Marage) significantly (P=0.01) outyielded the two exotic varieties. Their yield represented approximately twenty-nine bags of shelled dry beans per hectare—i.e. equivalent to 15 bags per acre. In gross monetary terms, this yield is equivalent to Sh. 1,450 per hectare or Sh. 750 per acre. These returns are based on the price of Sh. 70 per 90 Kgs bag paid by Maize and Produce Board.

To date, dry beans are grown mainly for food in Taita Hills. However, considering the yield obtained under 4 months of cropping, and hence the possibility of growing 3 crops in one year, it should also be possible to grow the crop as a profitable cash crop for the area.

ARABLE FOOD AND CASH CROPS—J. R. Goldson

Sugar-cane Time of Planting/Time of Harvest Trial

A trial to compare three dates of planting in the short rains (August, September and October) and three periods for the plant crop (12, 13 and 14 months) was harvested in 1969 after the plant crop.

Test variety was Co. 421 and all plots received double superphosphate at 250 Kgs per hectare and 375 Kgs/hectare of sulphate of ammonia. Yield levels in the trial were good as shown in Table VI.

TABLE VI—SUGAR-CANE YIELDS (TONNES/HECTARE)

Period of plant crop (Months)	Date Planted			
	August	September	October	Mean
12	71·763	76·139	83·992	77·298
13	75·267	89·921	110·461	91·883
14	82·661	92·849	123·326	99·612
Mean	76·563	86·303	105·926	89·597

Least significant differences (Between treatment means) ..	5% =	5·513
	1% =	7·679
	0·1% =	10·555
Coefficient of Variation	=	11·36 per cent

Later planting in the short rains has given significantly higher yields—factor noted in earlier trials. This is thought to be due to the fact that cane planted at the end of the short rains in October/November, goes through the dry months of December-March in a stage of growth more suitable to withstand drought conditions than earlier planted cane which has made growth before the onset of the dry months. On the evidence of this trial harvesting at 14 months in the plant crop as practised at present should continue.

Sugar-cane Variety Trial under Irrigation

Nine varieties of cane in a randomized block design under overhead sprinkler irrigation were harvested after 14 months in the plant crop at Fahamuni-Ramisi. All varieties received a total of 250 Kgs/hectare of double superphosphate at planting and thereafter 962.5 Kgs/hectare of sulphate of ammonia topdressed in three equal applications. Yields were disappointingly low, due, it was thought, to the poor irrigation interval. Over the period of the trial it was calculated that irrigation fell below the required amount by 225 mm approximately.

Results, in tonnes per hectare cane and juice analysis figures are given in Table VII.

TABLE VII—SUGAR-CANE YIELD UNDER IRRIGATION TONNES/HECTARES

Order	Variety	Yield	Brix	Pol	Priority
1	NCo 334	114·71	19·62	17·63	89·29
2	B 41227	114·53	19·61	17·58	89·56
3	NCo 376	107·83	19·85	17·79	89·90
4	Co 421	102·01	19·85	17·71	89·33
5	NCo 310	101·13	19·84	17·63	88·59
6	N 10	87·55	19·80	17·72	89·14
7	N 50/93	85·15	19·87	17·77	89·55
8	Co 775	82·63	19·84	17·73	88·77
9	CP 20/305	59·84	19·85	17·79	89·90
	Mean	95·04			

Least Significant differences	5%	21·01
	1%	28·97
	0·1%	39·81

Coefficient of Variation 18·09 per cent

Varieties N 50/93 and N10 were badly infected with smut and their cultivation is not recommended in the area, although the first variety should be watched carefully for smut.

Sugar-cane Variety Trial (Rainfed)

A 12 variety trial in a randomized block design, counterpart to the irrigated trial was harvested at Ramisi after 14 months in the plant crop. Results are given in Table VIII.

TABLE VIII—SUGAR-CANE VARIETY TRIAL YIELDS (TONNES/HECTARE) AND JUICE ANALYSIS

Order	Variety	Yield	Brick	Pol	Priority
1	Co 798	95·41	19·74	17·55	88·86
2	Co 746	90·89	19·67	17·67	89·19
3	Co 331	89·76	19·64	17·65	89·44
4	Co 421	88·05	19·47	17·66	89·65
5	CP 29/305	86·72	19·11	17·14	89·42
6	N10	83·88	19·74	17·53	89·69
7	Co 775	83·83	19·61	17·57	89·37
8	NCo 334	83·31	19·84	17·33	89·45
9	NCo 293	82·18	19·64	17·73	89·78
10	NCo 382	81·98	19·91	17·56	89·48
11	NCo 310	72·46	19·47	17·45	89·76
12	Co 779	71·28	19·71	17·71	89·36
	Mean	84·14			

Least Significant Differences 5% = 15·71
1% = 21·36
0·1% = 28·74
Coefficient of Variation 11·03 per cent

Only varieties—Co. 331, Co. 798, Co. 746 and CP 29/305 were completely clear of smut. The disease was particularly bad on varieties NCo. 382 and NCo. 293. Despite some of them showing a good performance in this trial, four varieties—N10, Co. 779, Co. 798 and NCo. 382 have been rejected for commercial planting, due to their high smut susceptibility based on their showing in smut testing blocks. Variety NCo. 293 is also border line of the remaining seven varieties—four are already in commercial production—Co. 421, Co. 331, Co. 775 and NCo. 334. It would appear that two of the remaining varieties Co. 746 and CP 29/305 should be bulked prior to further trials, although it must be noted that the last variety gave a disappointing performance in the irrigated variety trial.

Fertilizer Rates Trial

A fertilizer rates trial which started at Mtwapa in 1966 was planted in the 1969/70 season with vetiver grass as the test crop. Details of treatments and yields are given in Table IX.

TABLE IX—YIELDS OF DRY VETIVER GRASS ROOTS (TONNES/HECTARE)

Levels	Double Kgs.	Superphosphate hectare (42% PIOs) 0	125	250	Farm Yard Manure (tonnes/hectare) 0	8·4	16·8	Mean
Sulphate of Ammonia ..	0	1·646	1·526	1·200	1·338	1·766	1·269	1·457
	187·5	1·612	1·869	1·629	1·509	1·852	1·749	1·703
(21%N) Kgs/Hectare ..	375·0	1·972	2·469	1·766	1·629	2·435	2·144	2·069
Double Superphosphate (42% P_2O_5)	0				1·544	1·887	1·801	1·744
	125				1·732	1·315	1·818	1·955
Kgs/Hectare	250				1·201	1·852	1·544	1·532
Mean					1·492	2·018	1·721	1·743

Least significant differences 5% = 0·379
1% = 0·524
0.1% = 0·724
Coefficient of Variation = 21·68 per cent

There was a significant response to nitrogen, Farm Yard Manure and Phosphate especially so when these treatments were applied at the rates of 375 kgs, 16.8 tonnes and 125 kgs per hectare respectively.

It should be noted that vetiver was the 6th arable test crop on this site, and it would appear that with adequate nutrient application very good yields can be obtained from this crop at the end of an arable rotation. The crop is very responsive to fertilizer application. The mean yield of the trial was extremely good at 1.743 tonnes/hectare (equivalent to 0.694 tons/acre) with best treatment yields up to nearly 2.5 tonnes which compares very favourably with yields obtained in the present vetiver producing countries.

Tree Crops—B. R. Adams

Bixa.—A long term pruning trial utilizing 6-year-old bushes in a commercial field at Mtwapa was commenced in 1966. The object of the trial was to investigate the effect on yield of various pruning regimes.

The experiment was laid out as a 5 × 3 factorial design with 4 replicates. Each plot contained 15 bushes in a single row at a spacing of approximately 2.7 × 2.7 metres.

Treatments were as follows:—

Height of pruning	*Frequency of pruning*
A. Unpruned.	1. Annually.
B. Pruned to 15 cms.	2. Every two years.
C. Pruned to 46 cms.	3. Every three years.
D. Pruned to 91 cms.	
E. Pruned to 137 cms.	

In all cases bushes were pruned to a level "table" at the desired height. This operation was performed in April or May of each year following commencement of the main rains. Any seed produced between April and July is normally of poor quality due to the rain damage.

Early history of bushes in the trial area is obscure. They are known to have been pruned to 15 cms in 1965. Establishment was by seed. This was collected locally from bushes grown as ornamentals. At the commencement of the trial all plots were pruned with the exception of treatments A.

Apart from pruning, management of trial consisted solely of weeding between rows as necessary. No fertilizer applications were given. Pest control measures were not required as no pests of significance were observed.

A powdery mildew fungus was observed on a number of bushes within the trial area. This was identified as *Oidium sp.* In a few cases infection was sufficiently severe as to result in stunting and reduced fruit production. Many plants appeared completely immune to this pathogen.

Bushes within the trial were noted as being broadly classifiable into two types.

(i) Very vigorous with large bright red seed capsules.

(ii) Less vigorous with smaller dull red-brown capsules.

A suggestion that one type may be higher yielding than the other remains unproven. Bushes with bright red seed capsules were however observed as being much the more susceptible to the powdery mildew fungus.

Harvesting consisted of cutting fruit clusters as first capsules commenced opening. Capsules were then sun dried and thrashed.

Although planned as a long term trial the experiment was terminated at the end of the 1967/68 season. Reasons for this are as follows:—

(*a*) The poor future of the crop consequent upon small demand and world over production.

(*b*) The high labour requirement of the trial.

(*c*) Certain faults in the trial itself. Lack of internal guard rows resulted in shading of pruned treatments where next to unpruned bushes. Spacing of plants was noted as being very uneven.

The two years' results available are presented in Table X below:—

TABLE X—BIXA PRUNING TRIAL—TREATMENT YIELDS IN KG. OF CLEAN DRY SEED

Season	1966/67	1967/68	Total	Total Yield per Hectare
Treatment				
Unpruned	325·79	184·77	510·56	3,769·28
Pruned to 15 cms.	140·24	141·27	281·51	2,078·29
Pruned to 46 cms.	185·01	157·16	342·17	2,526·12
Pruned to 91 cms.	232·69	193·36	426·05	3,145·37
Pruned to 137 cms.	232·92	157·54	390·46	2,882·62
Pruned Annualy	395·71	264·09	659·80	2,922·64
Pruned every two years	354·46	264·04	618·50	2,739·70
Pruned every three years ..	366·47	305·97	672·44	2,978·63
Total Harvest	1,116·64	834·10	1,950·74	

Bushes in unpruned treatments were observed to crop throughout the year. Those pruned produced heavily between October and March compensating in part for yield lost earlier. December to March is the dry season at the coast. Seed produced at this time is of very good quality.

Due to the premature termination of this trial no statistical analysis of the yield figures has been attempted. The following points are, however, felt worthy of note.

Highest yields in the first season were recorded from those treatments unpruned or lightly pruned. Yields of those same treatment were markedly reduced in the second season. Lower yields of the more heavily pruned treatments in the first season were largely maintained in the second. Amongst the more heavily pruned treatments highest yields were recorded from those not pruned again in the second season. The opposite tended to be true of lightly pruned treatments. This last point is not reflected in the condensed results in Table X.

These results would indicate that regular pruning is necessary for maintenance of yields over a number of seasons. The fact that all bushes were heavily pruned one year prior to the start of the experiment is thought noteworthy. In addition pruning greatly facilitates management and ease of harvesting of this crop. Left unpruned Bixa plants rapidly assume the proportions of small trees.

On the basis of these results and observations an annual pruning to 1 metre can be recommended. If delayed until June or July maximum seed production following the October-November short rains would be encouraged.

Management studies on dairy cattle at the Kenya Coast

During the year intensive studies were commenced on the practice of keeping high grade dairy cattle in cashew tree shaded pastures in the coastal strip. Preliminary studies were aimed at identifying the benefits and disadvantages that were likely to arise when cattle were introduced to cashew plantations to graze the natural pasture herbage beneath the trees. Animal material was provided by lactating cows from the Mtwapa herd of pedigree and high grade Jerseys. Production and performance details of this herd have been given in the 1969 annual report. Investigations amounted to the recording of the behavioural, physiological and production response of 15 lactating animals when grazed in "open" and cashew shaded pastures. Trials were conducted at monthly intervals throughout a full year, intensive data recording being undertaken for 72 hours during each trial period after the cattle had undergone a suitable acclimatization period. The cattle grazed in alternate months the open and shaded treatments, thus giving a total of six sets of results for each treatment for the full year.

Both fields were of natural pasture and water was available at all times. The shaded pasture had cashews planted at 12 × 12 m spacing. The trees were planted in 1958 and at midday during the trial periods provided 48.97 per cent of the total field area with shade. The open pasture had four trees (mango and fig) and provided 2.77 per cent shaded area at midday. The cashew trees were pruned to allow access under the trees by the cows.

Behaviour responses were recorded for 72 continuous hours by a method previously described in the 1968 annual report for this station. Total water consumption by the herd was also recorded at 3 hour intervals throughout the day. Rectal temperatures were recorded for all individual cattle at 4.30 p.m. during the time the animals were at the dairy. Production, climatic data, pasture composition and quality were all recorded for each trial. A summary of the main findings is now given:—

Grazing times

This differed from month to month, season to season, between open and shaded pictures and between night and day. On average throughout the year, cattle grazed 29.6 minutes per day longer (sig 5 per cent) in the shaded pasture, this extra time being mainly during the day (as opposed to night-sunset to sunrise). Cows in the shaded pasture grazed 50.23 minutes longer in the day, and 20.63 minutes less at night than in open pasture. This indicated that although the shaded pasture appeared poorer in quality and quantity, conditions were more "comfortable" for the cattle under the trees.

Ruminating times

No significant difference between the two major treatments.

Lying times

There was a significantly ($P=0.01$) higher percentage of laying during the day in shaded pasture as opposed to the open pasture. Lying at night was the same for both treatments. Increased day lying indicates more comfort to the animal. An animal suffering from heat stress will stand rather than lie down.

Standing times

Corroborating evidence given in the previous section, there was a significantly (0.1 per cent) higher day standing time for cattle in the open pasture.

Rectal temperatures

Over the 12 trial periods rectal temperatures of all cattle at 1600 hours were on average 0.13°F higher in the open pasture treatment. However differences were greatest at the end of the dry season in March when rectal temperatures were significantly

higher (0.1 per cent) in the open pasture treatment by 1.07°F. This indicated a more favourable microclimate in the shaded pasture allowing the animals to regulate their body temperature more easily.

Number of drinks per animal

Animals in the open pasture took a significantly (0.1 per cent) greater number of drinks per day than in the shaded pasture—3.43 compared to 2.19. This difference was greatest in March—4.19 to 1.33. This difference appeared not to be due to treatments but to the siting of the water trough in the two treatment fields.

Free water intake

Shaded treatment cattle on average consumed more water than to open pasture cattle, 7.50 to 6.29 gallons/cow/day but this difference was at no time significant.

Pattern of walking

Track maps plotted from the movements of individual animals in the field showed that cattle movement in the shaded pasture was scattered throughout the entire area, whereas in the open pasture with limited shade move was concentrated to the area immediately adjacent to the shade trees. This difference was recorded mainly in the dry season and during the day. At night cattle in the open pasture rarely went near the shade, and in the wet season the cattle ranged over the whole field during the day. As the major portion of the grazing is done during the day it follows that during the dry season in open pasture cattle by restricting their movements to the close proximity to shade during the day automatically restrict their selecterity and possible intake of nature herbage.

Production

Although production levels from the animals was not significantly different for the two treatments there were strong indications that yields decreased when cows entered the open pasture and increased on entry to the shaded pasture. Trends were obscured to some extent due to the variable pro-trial treatment of the animals. Furthermore it was not known whether production changes were due to the effect of shade perse' or the change in herbage quality. It can be stated however that the presence of cashew shade appeared to have no detrimental effect on yields.

Grazing behaviour patterns

Three main peaks of grazing were recorded—post AM and PM milkings and a night period. There was little difference in the major peaks between treatments. However the night period was longer and more intensive in the open pasture during the dry season.

Contribution of the tree to the animal

Apart from the physical shade effects of the tree, both direct on the animal and indirectly, through the pasture, considerable data were collected on the contribution of the tree in the form of the cashew apple as a source of fodder. Apples were eaten from the ground by the cattle, and no observation was recorded of apples being taken direct from the tree. However it was noted that practically in all cases the nut was eaten with the apple. The nut was digested with no apparent ill effect despite the presence of the toxic cashew nut shell liquid. It appears therefore that grazing of cashew pastures during the cashew season has to be carefully controlled if nut yields are not to be reduced considerably. Analysis of fresh apples revealed a fairly static dry matter content ranging from 11.43-11.51 per cent. Protein and fibre content of apple dry matter ranged from 5.97-10.98 and 10.94-18.90 per cent respectively. Stall fed animals consumed up to 7.25 Kgs of fresh apples per day equivalent to 160 apples or 0.830 Kgs dry matter. Accurate yield records have not yet been completed but calculated yields based on nut yields indicate that plantations produce up to 6.275 tonnes/hectare of apples over the cropping season.

General conclusions

Results collected so far indicate that the benefits to be gained from the inclusion of cashews at a regular spacing within a pasture are likely to outweigh the possible disadvantages that may be found. Preliminary economic consideration indicate that the cashew pasture-cattle association is viable and economic. However it would appear that the study of the effect and contribution of the cashew tree on the beneath tree herbage is likely to be of more importance than the study of the same effects in the cattle, as the behavioral and physiological response of the animal is likely to be a product of the tree and pasture effect.

Crop Introduction and Testing

Yeheb nut (Cordeauxia edulis)

Observation and yield recording of 9 bushes of Yeheb planted at Mwakiki in 1955 was carried out over 2 years from 1968. Bushes are approximately 2 metres high, appear to be very resistant to dry conditions. Flowering takes place throughout the year but main flushes occur 2-3 weeks after rain. The seed or nut is enclosed in a semi-hard shell which carries a prominent beak. The nut is sweet and would appear to have limited possibilities for the dessert trade. Individual bush recording revealed that yields varied from nothing to 2.67 Kgs of nuts over 14 months of harvest. The top yield is equivalent to 2,676 Kgs per hectare based on a plant population of 1,000 plants per hectare. Samples of nuts have been sent to the T.P.I. London for assessment. If markets are found, the nut would appear useful for the dry marginal areas of the province.

J. R. GOLDSON,
Agricultural Research Officer-in-Charge.

RAINFALL RECORDS MTWAPA AND SUBSTATIONS (IN MILLIMETERS)—1970

Months	Mtwapa mean 11 years 1970	Mtwapa	Matuga	Gazi/ Ramisi	Ramisi Fahamuni	Taveta kimala	Taveta Kitobo	Wundanyi		Mariakani	Bomba	Msabaha	Nga
January	26·41	7·50	5·00	Nil	63·15	78·10	73·20	112·90	143·10	20·11	Nil	2·30	Nil
February	28·25	Nil	Nil	Nil	Nil	5·40	1·08	Nil	2·50	Nil	1·10	2·50	Nil
March	59·45	31·0	63·25	710·50	—	192·00	118·32	327·00	155·50	144·40	49·70	163·20	72·1
April	203·27	175·50	183·00	309·75	—	51·70	63·36	133·00	60·90	61·70	62·00	261·50	104·
May..	249·70	244·20	81·50	274·25	379·00	359·90	42·16	58·40	59·90	82·30	52·50	345·60	183·00
June..	151·41	56·00	47·50	58·25	98·00	Nil	Nil	9·60	0·20	28·40	6·10	47·50	38·00
July	94·55	65·50	37·25	55·50	70·50	Nil	1·00	16·00	4·60	25·20	22·70	84·90	57·00
August	81·42	35·20	49·50	28·00	57·25	0·40	Nil	58·20	3·80	44·90	13·80	39·00	22·00
September	77·91	35·20	41·50	16·25	52·00	1·50	Nil	20·20	0·55	14·20	27·80	16·80	20·00
October	126·88	14·70	17·95	Nil	Nil	Nil	Nil	4·40	1·30	6·10	5·40	67·10	28·00
November	138·55	15·50	17·75	38·40	32·00	61·30	68·30	136·10	89·90	24·50	22·70	23·30	30·00
December	36·94	43·30	52·25	41·00	97·28	29·25	72·76	198·55	61·80	19·00	199·80	34·50	76·00
TOTALS 1970	1,284·68	379·60	596·45	1,531·90	—	478·85	440·23	1,074·30	538·80	470·61	383·60	1088·20	633·00
TOTALS 1969	1,329·42	1,094·00	821·65	987·30	—	464·52	534·50	—	877·10	995·45	1,376·40	724·50	—

TABLE II—MONTHLY MEAN TEMPERATURES

(*a*) Mtwapa

Month	Maximum °C		Minimum °C	
	Highest Recorded	Mean	Lowest Recorded	Mean
January	32·78	31·30	21·65	22·10
February	32·22	31·15	20·55	21·00
March	32·22	31·65	21·15	23·30
April	32·22	30·30	21·15	23·50
May	30·55	30·00	21·65	22·10
June	28·85	27·00	20·00	21·75
July	27·75	22·20	20·00	21·10
August	28·30	22·20	20·00	20·55
September	28·85	28·00	17·75	20·80
October	30·00	28·80	23·88	24·80
November	30·55	28·85	20·55	22·20
December	32·20	31·05	21·65	22·50

(*b*) Matuga

Month	Maximum °C		Minimum °C	
	Highest Recorded	Mean	Lowest Recorded	Mean
January	33·00	31·50	21·50	23·67
February	34·00	32·02	23·00	24·50
March	34·50	32·50	23·00	25·00
April	33·00	31·10	21·00	22·75
May	31·00	28·80	21·00	21·95
June	30·00	28·15	21·00	21·08
July	28·50	27·06	20·00	20·33
August	29·00	27·15	20·50	20·20
September	30·00	27·66	19·50	21·00
October	30·00	28·61	20·50	21·32
November	30·50	28·73	20·50	21·75
December	32·50	31·19	21·00	23·12

(*c*) Msabaha

Month	Maximum °C		Minimum °C	
	Highest Recorded	Mean	Lowest Recorded	Mean
January	33·50	31·30	20·50	22·60
February	33·00	31·40	22·00	23·30
March	33·50	32·20	22·00	23·80
April	32·00	30·00	22·00	23·20
May	30·00	28·40	21·00	23·80
June	29·00	28·00	21·50	22·40
July	28·00	27·30	20·00	21·40
August	28·50	27·40	20·00	21·10
September	29·50	28·60	18·00	20·80
October	30·00	27·30	21·00	21·40
November	33·00	30·90	21·00	22·50
December	33·00	31·40	21·00	22·70

TABLE III—MONTHLY MEAN RELATIVE HUMIDITY 1970—MTWAPA

Month	Mean Dry °C Bulb	Mean Wet °C Bulb	Relative Humidity Per cent
January	28·4	23·9	68·0
February	29·2	24·7	66·5
March	30·3	25·1	64·0
April	28·5	24·5	72·5
May	27·0	23·6	72·5
June	25·9	23·0	76·5
July	25·8	22·3	74·0
August	26·00	22·4	71·0
September	26·20	22·3	70·0
October	27·30	22·5	66·0
November	28·6	24·0	56·0
December	28·8	23·8	62·0

EMBU AGRICULTURAL RESEARCH STATION

A.—Weather

Although the total rainfall figures for the year were slightly above the average for both Embu and Murinduko stations as shown in Table I below, the distribution of the rainfall over the year was very poor.

Well over two-thirds of the total annual rainfall in both the stations fell during the Long Rains (L.R.) i.e. from March to May and only about a third during the Short Rains (S.R.) from October to December. Consequently the area had fairly good harvests during the L.R., but had the worst S.R. season, and most of the experimental and farm crops were almost a complete failure.

TABLE I—RAINFALL AT EMBU AND MURINDUKO STATIONS—1970

	Embu		Murinduko	
	mm	Days	mm	Days
January	59·90	10	51·80	10
February	—	—	—	—
March	146·70	10	136·60	9
April	533·80	20	362·30	18
May	93·53	14	154·70	13
June	30·20	11	4·00	5
July	35·25	11	10·60	5
August	51·10	19	28·00	8
September	17·84	8	1·90	4
October	67·77	5	15·70	3
November	166·20	10	158·10	10
December	34·20	3	38·20	2
TOTAL	1,236·49	121	962·0	87
	Embu Total 1969		Murinduko Total 1969	
	980·8	125	883·1	99
Average	1,091·4		853·4	

B.—Reports on Experiments

I—Star Grass and Lower Kikuyu Grass Zone Embu Farm

A.—General Research Section

1. Fertilizer Rates Trial

The experiment which was first laid down in L.R. 1952 entered its 18th year. The objective of the experiment was to provide information with regard to the nutrient status of soils on the station and on soils of a similar type in the star grass zone of Central Kenya. The experiment is conducted on a rotational basis of 4 years arable crops and 4 years under a ley. This year the arable crop phase was ending and the trial was planted with a maize crop H 511 in L.R. 1970 and a bean crop (Mexico 142) in S.R. 1970.

The design is a 3^3 Nitrogen, Phosphorus and Farm Yard Manure with the highest order of interaction partially confounded. The rates of the fertilizer and manurial treatments applied are as follows:—

(*a*) Double superphosphate 0, 127.3, 254.6 Kg/ha.

(*b*) Nitrogen C.A.N. (26 per cent N) 0, 127.3, 254.6 Kg/ha.

(*c*) Farm Yard Manure 0, 13.6, 27.2 m. Tons/ha.

The fertilizer and manurial treatments are applied only during the L.R. and S.R. crop (which is usually a pulse crop) is used to test the residual effects. The yields of maize H 511 planted during the L.R. are presented in Table II below:—

TABLE II—THE YIELD OF H 511 IN QUINTALS/HECTARE

C.A.N. 26 Per cent	Double Supers			Farm Yard Manure			Means
	0 Kgs.	127·3 Kgs.	254·6 Kgs.	0 M. ton	13·6 M. ton	27·2 M. tons	
0 Kgs.	49·7	51·1	51·9	40·2	51·7	60·8	50·9
127·3 Kgs.	53·7	60·8	59·1	49·7	62·5	61·3	57·8
254·6 Kgs.	58·1	60·7	62·1	52·3	61·7	67·3	60·4
Mean	53·8	57·5	57·7				

Double Supers	0 Kg.	43·0	57·3	61·7
	127·3 Kgs. ..	48·1	60·3	64·3
	254·6 Kgs. ..	51·2	58·3	63·5
	Means	47·4	58·6	63·2

L.S.D. Marginal Means

5% = 3·47

1% = 4·71

C of V. = 8·89% 0·1% = 6·34

All the treatments gave significant increases in the yield but the greatest increase occurred in the manurial and nitrogen treatments. Nitrogen treatment gave a significant linear increase in yield of the maize at p = 0.001 level.

Double superphosphate applied at 127.3 and 254.6 Kgs/ha outyielded the nil treatment at p = 0.05 level of significance.

Farm Yard Manure gave the greatest positive increase in yield of maize. The increase in yield was significant at the p = 0.001 level.

2. LONG TERM ROTATIONAL TRIAL

This experiment is now on its fourth year. The objective of the experiment is to appraise the usefulness of the cropping systems currently carried on in different farming regions of Central Kenya as well as Embu and Meru districts of Eastern Province. The cropping systems being investigated are:—

(*a*) Continuous maize in a monoculture (phase A).

(*b*) Continuous intercropping of maize and beans (phase B).

(*c*) An eight years full rotation of Irish potatoes—Maize—sweet potatoes—maize undersown with grass. The grass ley to remain in the field for four years (phase C).

(*d*) Rotation of arable crops without going into a ley as follows:— Irish potatoes—Maize—sweet potatoes and Maize (phase D).

The rotational treatments are then split for farmyard manure (M) and N.P. fertilizers at two levels. The rates used are:—

(i) Calcium ammonium Nitrate (C.A.N. 26 per cent N) 127.3 Kg/ha *v.* nil.

(ii) Single superphosphate (21.5 per cent P_2O_5) 254.6 Kg/ha *v.* nil.

(iii) Farm yard manure (FYM) 90.7m. tons/ha applied in 8 years *v.* nil.

During the L.R. 1970 maize crop H 511 which appeared in all the rotational systems was used as an index of testing the effect of the other crops in the rotation.

Table III shows the yield of maize H 511 in quintals per hectare from the rotational and fertilizer treatments.

TABLE III—YIELD OF MAIZE H 511 IN QUINTALS/HECTARE

Fertilizers	Rotations						Means
	A	B	C1	C7	D1	D3	
(1)	25·3	37·3	49·9	59·1	38·7	64·0	45·7
n	42·9	41·5	49·9	62·6	39·4	48·5	47·5
p	47·1	40·1	48·5	65·4	101·9	59·8	60·5
np	41·5	41·5	57·0	58·4	68·2	59·1	54·3
m	47·8	47·1	49·9	61·2	53·4	62·6	53·7
nm	26·0	37·3	41·5	33·8	55·5	42·9	39·5
pm	47·1	52·7	57·0	66·8	62·6	28·8	52·5
npm	47·8	45·0	62·6	66·8	65·4	68·2	59·3
Means	40·7	42·8	52·0	59·3	60·6	54·2	

		L.S.D.	5%	1%	0·1%
		Fert.	6·41	8·63	11·44
C of V.—Rotation	12·85%	Rotat.	9·84	15·43	26·29
C of V.—Fertilizer	21·07%				

There were significant differences in yield due to rotational treatments. Phases A/B i.e. continuous maize in a monoculture, and continuous intercropping of maize and beans respectively were significantly outyielded by phases C and D i.e. the rotation phases as described under treatments. Phases C_7 and D_1 significantly ($p=0.01$) outyielded phases A and B level whereas phases C_1 and D_3 outyielded A and B at the $p = 0.05$ level.

There was no significant difference in yield between the C and D phases.

3. PASTURES

1. *Napier Grass Variety Trial*

The trial first established in 1966 L.R. was concluded at the end of 1970. It consisted of six varieties of napier grass. It was laid down as:—

A 6×6 Latin square and in 1968 all the plots were split for nitrogen application at the rate of 227 Kg/haN. versus nil.

Table IV gives the yield of the napier grass varieties with and without nitrogen from 1968-70 in metric tons per hectare.

TABLE IV—YIELD IN METRIC TONS PER HECTARE GREEN FRESH WEIGHT OF NAPIER GRASS VARIETIES

Varieties	YIELD IN METRIC TONS/HA							
	1968		1969		1970		3 Years Mean	
	N_0	N_1	N_0	N_1	N_0	N_1	N_0	N_1
French Cameroon ..	147·1	155·4	87·5	97·9	79·6	94·7	104·7	116·0
Ex-Meru	116·1	138·8	59·9	74·7	64·5	76·1	80·2	96·5
Ex-Limuru	86·5	102·9	45·0	52·5	47·0	55·2	59·5	70·2
Uganda Hairless ..	80·7	108·3	35·4	55·5	39·1	57·7	51·7	73·8
Gold Coast	90·1	111·2	48·9	63·6	39·0	55·7	59·3	76·8
Cameroon	70·0	96·2	28·2	36·3	30·0	34·5	42·7	55·7
Mean	98·4	118·8	50·8	63·4	49·9	62·3	66·4	81·5

For 1970 Yields only

L.S.D.	5%	1%	0·1%
Varieties ..	4·71	6·43	8·70
Nitrogen ..	5·74	7·73	10·25

C of V. Varieties = 24·17%
C of V. Nitrogen = 21·27%

Varieties French Cameroon, Ex-Meru and Gold Coast in order of their potential yield respectively, have constantly outyielded the other varieties significantly over the experimental period. 1968 was a fairly wet season compared to 1969/70 and hence all the varieties gave very high yields. Normally after the first year of establishment napier grass gives the highest yield, and thereafter there seems to be a reduction in yield as the stand grows older.

Nitrogen treatment has also given significant yield increase. The three mean yields show that there was an increased yield of 15.1 metric tons/hectare fresh green weight by applying 227 Kg/ha N versus nil. The plots receiving nitrogen were also observed to be yielding more material during the dry spells than the plots without.

2. *Forage Sorghum Variety Trial*

The objective of the trial which was planted during the S.R. 1969 was to evaluate eleven different forage sorghum varieties under Embu conditions.

The yield of two cuts taken from the varieties in Kg/ha is presented in Table V.

TABLE V

Varieties	1st Cut	2nd Cut	Total
Grazer A	6,300	2,580	8,880
Gahi (Millet)	5,100	2,240	7,340
Sudax Sx16	5,370	1,880	7,250
Hay Grazer	3,600	2,620	6,220
Chowmaker C	3,450	2,560	6,010
Sweet Sioux	4,020	1,940	5,960
Trudan 2	3,700	1,620	5,320
Sure Graze G	1,900	1,500	3,400
Velvet sorghum	2,170	980	3,160
Sudan grass	1,050	1,220	2,260
Columbus grass	800	980	1,780
C of V	50%	41%	38%

The variety effect was significant at P = 0.01 level of significance at both samplings. Variety Grazer A was the overall best and also best in the first cut. Variety Hay grazer was the best at the second cut.

Exploratory Banana Fertilizer Trial

The trial was laid down during the L.R. 1966. Variety Muraru was used to test the fertilizer effects. The bananas are all planted in a pit 1.22 metres square and 1.22 metres deep, and spaced at 2.74m by 2.74m.

The treatments applied are:—

(i) Control—where neither fertilizer nor FYM was applied.

(ii) Farm yard manure (FYM) at the rates of 53.8 m tons/ha.

(iii) Calcium Ammonium Nitrate (26 per cent N) at the rate of 448.0 Kg/ha.

(iv) Single superphosphate 560.0 Kg/ha.

(v) Muriate of potash 336.0 Kg/ha.

(vi) A combination of muriate of potash, single superphosphate and farm yard manure at the above rates.

(vii) A combination of muriate of potash, single superphosphate at same rates.

(viii) A combination of muriate of potash, single superphosphate and calcium ammonium nitrate.

The mean yield of the banana bunches in Kg/ha are presented in Table VI.

Table VI—Mean Yield in Metric Tons/ha. of Banana Bunches for 1968, 1969 and 1970

Treatments	1968	1969	1970	3 years Means
1. Control	23·03	17·51	21·29	20·61
2. 53·8 m. tons/ha. FYM	41·59	19·92	18·94	26·82
3. 448·0 kg./ha. CAN (26%N)	17·37	27·00	17·49	20·62
4. 560·0 kg./ha. S/supers	24·94	21·09	19·90	21·98
5. 336·0 kg./ha. Muriate of potash ..	19·76	26·71	19·30	21·92
6. Combination (v) + (iv) + (ii) ..	35·11	30·40	19·03	28·18
7. Combination (v) + (iv)	32·90	33·66	21·06	25·87
8. Combination (v) + (iv) + (iii) ..	22·95	29·57	23·45	22·95
C of V.	34·67%			
L.S.D. P =	0·05	0·01	0·001	
	2·03	2·73	3·60	

The yields for 1970 were not affected significantly by the treatments under investigation. The three years' means indicate that treatment six, i.e. a combination of muriate of potash, single superphosphate and farm yard manure gave the highest average yield. Farm yard manure alone was next best and this indicates that well prepared good farm yard manure by itself would give relatively good yield of bananas.

Grass Woodland Zone Murinduko Farm

(*1,279.6m above sea level and 853.4mm average rainfall*)

1. Banana Variety Trial

This trial was laid down in 1963 to compare twelve banana varieties in relation to their yield palatability and local market value.

All the varieties were established in pits 1.22 m square and 1.22m deep, spaced at 3.66 × 3.66m. Two debes of farm yard manure and 1 Kg of double superphosphate were mixed with soil and put into each pit. All the plots were kept well mulched.

The yield of the banana varieties during 1969/70 are presented in Table VII.

TABLE VII—MEAN YIELD IN M. TONS/HA. OF THE 12 BANANA VARIETIES

Varieties	Yields M. Tons/ha.	
	1969	1970
Kiambu	37·67	25·36
Ndunuku	40·58	22·73
Uganda Red	40·37	22·42
Mutavato	45·96	21·75
Mutondo	27·80	21·12
Gitigi	32·28	16·95
Mucuru	28·70	14·86
Uganda Green	31·61	12·42
Mutika	40·36	11·57
Chinese dwarf	25·11	8·59
Muraru	14·80	8·52
Ndugu	32·51	7·89
C of V.	23·72%	39·05%
L.S.D. mean yields	5%	1% 0·1%
	10·69	14·53 19·55

There was a marked drop in the yield of the bananas as compared with the previous years. Despite the poor rainfall during the year which might have caused the reduction in yield, it has been observed from the previous years that bananas at Murinduko follow a cycle of high yield levels in different years. The first crop to harvest after establishing a banana stand normally gives a heavy yield, this is followed by two years of low yield and again another high yield.

The following varieties have maintained higher yields over the others:— Kiambu, Ndunuku, Mutavato and Gitigi. The preference for cooking and ripe bananas is as follows:— for cooking: Mutavato, Gitigi, Ndunuku, Ndugu Mutika and Uganda Red. For eating when ripe: Muraru, Mucuru, Mutondo, Chinese dwarf, Mutika and Ndunuku.

2. ROTATION TRIAL

This is a long term experiment laid down to appraise the usefulness of cropping systems currently carried on in different parts of the lower regions (Grass woodland zone) of Central Kenya. It was laid down during the Long Rains of 1968.

The cropping systems are:—

A. Continuous maize in a monoculture both long and short rains.

B. Continuous maize and beans (interplanting both long and short rains).

C. 8 years rotational cycle in which there would be 4 years of arable crops and 4 years of grass ley. The crops grown and their sequence are:— Irish potatoes—cotton—sweet potatoes and maize.

D. 4 years rotational cycle in which there would be planted Irish potatoes—cotton—sweet potatoes and Maize. Both maize and cotton to be succeeded by beans in the short rains.

The rotational treatments are split for farm yard manure, Nitrogen and phosphorus application at two levels, with and without.

The rates applied are:—

(i) Single superphosphate nil *v.* 200 Kg/ha.

(ii) Nitrogen (C.A.N. 20.5 per cent N) nil *v.* 100 Kg/ha.

(iii) Farm yard manure nil *v.* 7.6 m. tons/ha.

The yield of maize crop (Kat. Co. B) which appears in 4 rotational phases planted during the L.R. 1970 is shown in Table VIII.

TABLE VIII—YIELD OF MAIZE IN Q/HA. FROM THE VARIOUS ROTATIONAL AND FERTILIZER TREATMENTS

Treatments Fertilizers	ROTATIONS					Means
	A	B	C_2	C_3	D_2	
(i)	24·3	17·4	34·3	30·8	24·7	26·3
n	37·3	54·3	52·1	27·3	47·3	43·7
p	30·4	41·2	44·3	31·7	44·7	38·5
np	32·1	33·4	50·4	33·0	54·3	40·6
m	33·4	49·5	55·1	48·2	55·6	48·6
nm	42·1	47·3	59·5	39·5	43·8	46·4
pm	37·8	33·9	53·8	46·9	43.0	43·1
npm	56·4	33·0	54·3	55·6	57·3	51·3
Means	36·7	38·7	50·5	39·1	46·3	

C of V—Rotation .. 13·89%
C of V—Fertilizer .. 17·60%

L.S.D.	p = 0·05	p = 0·01	p = 0·001
Rotation means	10·36	17·19	32·14
Fertilizer means	4·85	6·59	8·81

The rotation phases where monoculture is being followed i.e. phases A and B are giving lower yields than the other phases where alternation of crops in different seasons (C and D phases) is being carried out. Phases D_2 and C_2 significantly ($p=0.05$) out-yielded phases A and B.

The maize also responded to the fertilizer and manurial treatments. The application of nitrogen, manure and phosphorus resulted in significantly higher yields than the nil treatment. The biggest response in yield was realized from the manurial treatment.

MAIZE BREEDING

EMBU MAIZE RESEARCH SECTION—MAIZE BREEDING

Long Term Programme

As reported in 1969 Annual Report, this programme is basically composed of two genetically divergent breeding populations i.e. Embu Composite 1 and Embu Composite 2. If their cross proves to be superior as the current hybrid for Central Kenya, these two will become the future parents of medium maturity hybrids.

They were both initiated in Long Rains 1967 from different coloured varieties. In the 5th generation of mixing the varieties coupled with a mild selection, it became evident from visual observation, that the varieties in both composites were well mixed. Hence during the March rains of 1967, S_1 testing selection for yield and against yellow colour were started. The S_1 seeds were planted in October 1970 rains for evaluation but the season was a failure. The evaluation phase will be repeated in the March rains of 1971.

Efforts to incorporate Opaque 2 gene into both composites were continued. This has been accomplished and the opaque versions of the composites were included in the last season medium maturity maize evaluation trial, which because of prolonged drought did not yield worthwhile results. The same trial will be repeated in 16 locations spread all over Central Province and Embu district.

Evaluation of Medium Maturity Maize Varieties: Combbined Means From Six Locations

Table IX—Yields in Quintals per Hactare

Entry No.	Variety	Yield	Stand count	Lodged plants	Bare tips	Usable ears	Diseased ears	days to tassle	Ear Height	Percentage to Muratha
1.	H632	34·7	98·0	46·9	15·4	91·3	14·5	66·1	182·5	121·5
2.	H512	42·1	97·2	42·9	18·7	82·5	5·2	58·1	171·7	147·4
3.	H511	33·7	96·2	42·5	21·3	80·1	6·3	55·4	146·7	118·0
4.	E.1C4×E11C4	40·4	96·7	35·6	5·6	95·1	7·8	59·9	177·7	141·4
5.	E1 C5	34·9	97·0	35·9	14·1	83·6	6·9	60·8	188·6	122·2
6.	E11 C5	37·5	97·7	31·9	10·8	80·4	4·9	59·1	173·6	131·2
7.	C1C3×SR52	37·6	96·2	41·9	10·9	93·3	7·4	63·8	197·7	131·6
8.	E11C3×SR52	38·4	93·7	37·7	14·5	80·2	6·3	58·3	156·2	134·4
9.	H512	46·0	98·0	33·0	13·2	89·8	6·1	58·6	166·3	161·0
10.	Yellow Maize	32·9	97·8	39·8	15·3	81·7	8·7	64·6	198·7	115·2
11.	Kat. Comp. A	25·1	97·9	50·9	6·5	72·9	11·3	47·1	97·5	87·8
12.	Muratha	28·2	95·7	31·4	5·9	66·5	7·3	56·7	153·0	100·0
	Mean	36·0	96·8	39·2	12·7	83·1	7·7	59·0	167·5	
	L.S.D.	10·9	5·6	17·0	10·5	15·9	8·4	5·8	21·8	

However, from visual observation at harvesting time, the opaque version are lighter and more shrivelled than the normals.

Short Term Programme

This programme feeds farmers with hybrids while waiting for a superior hybrid from the long term programme.

As had been indicated in the previous Annual Report, H 511 was outyielded by a cross SR 52 × H 511. The cross was 20 per cent better than H 511. This was based on the yields of a trial conducted in Long Rains 1969 and in 6 different locations. The same cross proved superior in trials conducted in 1970 Long Rains at 6 locations.

The cross SR 52 × H 511 was released this season to Central Kenya farmers as HYBRID 512.

MAIZE AGRONOMY SECTION—EMBU

In the long rains only two experiments were conducted both of which were being continued from previous years:—

1. *Fertilizer/Spacing Trial*

This was a continuation of the earlier District Cultural Trials. It had five levels of each of phosphate, Nitrogen and spacing (or population), viz. 0, 20.7, 70.7, 120.7 and 141.4 kg P_2O_5/ha; 0, 41.4, 141.4, 241.4 and 282.8 kg N/ha; 60, 40, 30, 24 and 20 cm within each row. All rows were at 75 cm spacing, giving plant population of (in thousands) 22.2, 33.3, 44.4, 55.5 and 66.7 per hectare. The trial was planted at the Research Station and Wambugu F.T.C. in Nyeri with hybrids 511 and 512 at each site.

Results

At the Research Station there were significant responses to Nitrogen ($p=0.05$) and spacing ($p=0.01$) with H 512, while H 511 responded only to spacing the increase being significant ($p=0.01$) Nitrogen application, was however, uneconomic.

Though there were no significant responses to either fertilizers or spacing at Wambugu Centre with H 512, H 511 responded to both phosphate and spacing the increases in yield being significant at 5 per cent and 1 per cent level respectively.

TABLE X—YIELDS OF H 511 (Q/ha.) AT THREE P_2O_5, LEVELS AT TWO SITES

P_2O_5, Kg./ha.			
Site	20·7	70·7	120·7
Embu	68·28	65·20	68·12
Wambugu	65·95	72·12	77·08
Means	67·11	68·66	72·60

TABLE XI—YIELDS OF H 512 (Q/ha.) AT THREE NITROGEN LEVELS AT TWO SITES

N. Kg./ha.	41·4	141·4	241·4
Site			
Embu	73·80	77·43	80·04
Wambugu	72·91	76·13	80·53
Means	73·36	76·78	80·28

TABLE XII—YIELDS OF H 512 AT THREE POPULATIONS (Q/ha.) 1970

Plants per hectare ('000)	33·3	44·4	55·5
Site			
Embu	71·09	77·43	77·56
Wambugu	70·77	76·13	78·00
Means	70·93	76·78	77·78

TABLE XIII—YIELDS (Q/ha.) OF H 511 AT THREE POPULATIONS

Pop. (thousands)	33·3	44·4	55·5
Site			
Embu	61·38	65·20	65·48
Wambugu	64·36	72·12	80·81
Means	62·87	68·66	73·14

Closer spacing of maize significant (p=0.001) increased lodging with H 512 at both sites, while phosphate decreased it the decrease being significant at 5 per cent level. At Wambugu, too, increasing Nitrogen was accompanied by increased lodging.

Probably because cobs were small in size at high populations, increasing plant population very significantly decreased bare tip percentage. Usable ears were also increased as the population decreased, probably due to less lodging at the low population which thus decreased rotting.

Summary

From the results of this year's Fertilizer/spacing trial it was found that both phosphatic and nitrogen fertilizers were not effective in increasing maize yield. Where nitrogen did, it was uneconomic to apply it. Phosphate, however, helped in decreasing lodging in H 512 at Embu.

Population increased yields of maize and decreased the problem of bare tip. It, however, increased lodging and diseased ears.

2. *Time of Planting/Spacing Trial* 1970

This experiment was a continuation from the previous years. The treatments studied were four times of planting i.e. planting at weekly intervals from the start of rains. Interaction between time of planting and plant population was also investigated. The results of the trial are summarized in Table XIV.

TABLE XIV—YIELDS Q/ha. OF FOUR TIMES OF PLANTING AND FIVE POPULATIONS EMBU 1970

	T_1	T_2	T_3	T_4	Means
S5	67·52	54·02	54·57	52·72	57·21
S4	76·40	72·15	76·77	67·52	73·21
S3	61·60	84·17	73·07	67·71	71·64
S2	74·00	78·62	83·25	75·85	77·93
S1	81·40	79·55	68·45	61·97	72·84
Means	72·18	73·70	71·22	65·15	

L.S.D.		P=0·05	P=0·01
Time	T =	7·07	N.S.
Spacing (Population)	S =	9·23	16·49
T × S	=	18·57	N.S.

There was a definite decrease in yield as planting was delayed after rains started. Planting any time within two weeks after onset of rains did not differ significantly, however. This is perhaps understandable since rains continued until August, giving a total of 583.6 mm of rain during the whole of the growing season.

Decreasing the spacing within the row (increasing the plant population) increased yield, although this dropped at the highest population (88.889 plants/ha) due to too much rotting as a result of high lodging percentage.

Beans M. 142 Time of Planting—L.R. 1970

This was an experiment designed to investigate the most appropriate time of planting for beans in the Long Rains season at Embu. The experiment was planted as a 4×4 Latin Square, spacing was uniform at 45 × 10 cm and good husbandry practices were observed.

Beans (variety Mexico 142) were planted on four dates at weekly intervals, the first planting carried out about a week from the time the rains started.

Results of the experiment are summarized in the table below:—

Table XV—Treatment Yields (Q/ha.)—Beans Top

T_1	T_2	T_3	T_4	S.E.
24·7	17·6	13·2	14·1	±1·5
	p =	0·05	p =	0·01
L.S.D.		3·4		4·9

Early planting (T_1) significantly (p=0.01) outyielded all later planting.

The actual planting was done approximately one week after rains had started although dry planting was intended.

T_2 planted a week after T_1 also outyielded the later two plantings. The difference in yield being significant at the 5 per cent level.

Yield increased, though not significantly, at the latest planting, but this may be attributed to a short drought spell that followed T_3 planting. As a result the growth of the last two plantings did not look different, the final yields being nearly the same.

Bean Husbandry Trial—Embu L.R. 1970

This trial was a repetition of a 1968 trial which had been discarded.

The main objectives were to find out:—

(*a*) The proper spacing between the rows
and (*b*) the response to phosphatic and nitrogenous fertilizers.

There were two levels each of phosphate, nitrogen and the inter-row factor. The spacing within the row was at three levels. The levels were as follows:—

0 and 50 Kg P_2O_5/ha

0 and 25 Kg N/ha

30 and 45 cm between rows

8, 10 and 15 cm between hills in each row.

Thus it was a $2^3 \times 3$ factorial trial. Three replications were planted at the Research Station farm. The results are tabulated below:—

TABLE XVI—YIELD OF DRY SHELLED BEANS (Q/ha.)

Inter-row Intra-row	A_1	A_2	Total	Mean
S_1	27·86	22·96	50·82	25·41
S_2	25·31	22·18	47·49	23·75
S_3	24·19	20·39	44·58	22·20
TOTAL ..	77·36	65·53	142·89	
Mean	25·78	21·88		

L.S.D. at p = 0·001
A = 1·48
S = 1·72

Neither phosphate nor nitrogen gave significant response to the yield of Mexico 142 Beans. The inter-row spacing of 30 cm outyielded the one of 45 cm at 0.1 per cent level. Similarly the closest intra-row spacing of 8 cm outyielded 10 and 15 cm spacings significantly from a population of 416, 667 plants/ha spaced at 30 cm × 8 cm.

The yield of Mexican 142 beans, therefore, according to this experiment was not limited by soil fertility, but by population. This was the case in a normal year and in a soil that had received fertilizer in previous seasons, thus raising the fertility above the threshold for beans. In early stages of growth the beans in plots without nitrogen showed lighter green foliage, but soon afterwards they were unrecognizable.

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Agricultural Research Officer-in-Charge.

NYANDARUA AGRICULTURAL RESEARCH STATION, OL JORO OROK

1.—Review of the Year

The distribution of the rains was very poor and although the total amount of rainfall for the year was nearly the same as for 1969, the poor distribution adversely affected the yields of wheat, barley, oats, linseed and potato crops. Table I is a summary of the rainfall data for 1969 and 1970.

TABLE I—RAINFALL IN MM.

Month	1969	1970	1970 Rainy days	Average for 23 days
January	38·61	100·9	17	64·01
February	88·39	1·0	1	11·81
March	45·47	69·4	111	55·40
April	23·62	107·8	16	111·94
May	100·84	75·2	16	97·55
June	21·59	129·0	13	108·57
July	141·73	101·8	15	126·34
August	84·58	148·9	24	157·76
September	134·87	87·3	16	85·44
October	21·65	35·0	10	44·93
November	102·70	16·0	10	43·31
December	8·80	7·3	5	37·82
TOTAL	812·85	879·6	154	944·88

As a result of improvement to the pastures on the station, livestock did well. Infertility in cattle had been solved by the provision of a balanced supply of sufficient minerals. In the past, it had been thought that infertility was connected with bad artificial insemination or infection of cows but after trials with minerals it became evident that the minerals derived from pastures alone were inadequate to meet the requirements of the cows. This finding has gone a long way to improve the fertility of the cows on the station.

The timing of sheep tupping, lambing, wool clipping and good pastures, greatly helped to improve and reduce the mortality of lambs. The problem was found to be connected with lambing either when the weather was very hot or when it was very cold. Although it is generally hard to time the lambing to coincide with the weather, this had been achieved with good results.

2.—Experiments

(a) Bulking of desirable potato seeds

Six tubers each of three varieties, B53, C52 and C53, imported from Scotland in 1966, have been bulked at the station. Their performance has been generally good, except there has been a slight attack of early blight on C52. B53 has been free from blight since 1966. Since 1966 bulking has yielded 151 bags of B53, 18 bags of C52 and 31 bags of C53, giving a total of 200 bags. These have now been released to farmers to be grown as certified seed for more bulking and distribution to other farmers.

(b) Fertilizer trial on Linseed

The fertilizer experiment on linseed laid down this year has not shown any differences between different rates of fertilizers. This may be due to some limiting factor which has not yet been discovered. However it is proposed to lay another experiment using a different design preferably a Latin square design so as to try and find the optimum fertilizer requirements in order to make recommendations for farmers.

(c) Linseed seed rate

This is also another experiment that is receiving much attention, but due to shedding before harvesting it was not possible to obtain data for statistical analysis. The experiment will be repeated using properly selected seeds so that differences in ripening may be reduced to a minimum. This would necessarily reduce shedding.

(d) Observational Maize Trial

The seed was obtained from Kitale where it was previously grown on Mt. Elgon. This crop took eight months to grow to maturity and when harvested the yield was 11 bags per acre with only double superphosphates applied at planting time. No top-dressing with nitrogen was carried out. This was unusual because the maize grown in this district while giving yields in excess of 11 bags per acre it takes over a year to mature. The trial is continuing with further selection in order to get a high yielder as well as a quick maturing variety.

(e) Observational Fruit Trial

This experiment has been very successful and all the apples budded, about 90 per cent took and have been growing well and also transplants are doing well. Several trees have been sold to farmers in the district and these have proved successful.

(f) Observational trial on Sweet Potatoes

There has not been much activity in growing sweet potatoes in Nyandarua district either for tubers or for vines. The station has started with 3 varieties to see whether at this altitude it is possible to have a good variety of sweet potatoes which can produce good tubers for consumption as well as abundant vines for grazing.

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Agricultural Research Officer-in-Charge.

WESTERN AGRICULTURAL RESEARCH STATION, KAKAMEGA

A.—Weather

The Long Rains started a little earlier than usual i.e. in January and continued through to September. While the distribution was, in general, good, the end of the crop season, July to September, particularly at Kakamega, was too wet thus making harvesting of the maize crop difficult.

The Short Rains season of October to December was rather dry. However, this was of great benefit to the farmers who were busy moving the maize crop from the farms especially in the two maize growing districts of Kakamega and Bungoma.

The rainfall data for the three main centres where investigations are undertaken are summarized in Table I.

TABLE I—RAINFALL IN mm. FOR RESEARCH STATIONS IN WESTERN PROVINCE

Month	KAKAMEGA		SANGALO		BUSIA	
	Amount	Days	Amount	Days	Amount	Days
January	140·0	22	129·0	15	132·8	12
February ..	125·8	13	20·0	6	65·1	7
March	250·7	20	234·0	16	159·9	20
April	273·1	20	290·0	19	394·1	24
May	218·2	27	225·0	27	271·1	24
June	148·4	19	70·0	16	63·3	15
July	218·9	16	78·1	20	79·9	9
August	303·4	25	137·5	20	257·2	22
September ..	208·7	26	127·0	21	255·0	20
October	68·5	19	155·0	22	162·0	22
November ..	105·7	16	106·5	13	69·3	15
December ..	50·7	8	73·5	7	37·0	9
TOTAL ..	2,112·1	231	1,645·6	202	1,946·7	199

B.—Reports on Experiments

1.—NITROGEN RATES ON MAIZE—UYOMA

The object of the trial was to study the response of maize to nitrogen fertilizer application. Nitrogen was tested at five levels, *viz.*:— N_0—0 kg/ha; N_1—270 kg/ha; N_2—540 kg/ha; N_3—810 kg/ha and N_4—1,080 kg/ha. Nitrogen was applied in the ammonium sulphate form (21 per cent N), and the trial was laid down in a simple randomized block design. The yield data for the trial are presented in Table II.

TABLE II—YIELD OF GRAIN IN Q/ha.

Treatments	N_0	N_1	N_2	N_3	N_4	*Mean*
Yield	34·9	41·6	43·9	43·1	44·0	41·5

L.S.D. 5% = 13·2
C.V. = 23·0%

The data show that there was no significant difference between the fertilizer treatments. It must however, be noted that striga weed infested the trial heavily and this could have significantly contributed to the lack of yield differences due to fertilizer application.

2.—Kenaf Fertilizer Trials

The trials were planted, one each at Busia and Sangalo to study the effect of nitrogen, phosphorus, potassium and calcium on Kenaf fibre yields. The fertilizers were tested at two levels i.e. Nil *v.* 200 kg/ha N(ASN); Nil *v.* 1.5 m. ton/ha Agri. lime; Nil *v.* 400 kg/ha. Double supers and Nil *v.* 200 kg/ha. Potash (muriate of potash). The design was 2^4 factorial with the higher interaction confounded. Tables IIIa and IIIb are a summary of the trial results at Sangalo and Busia respectively. On the whole the yields of Kenaf fibre were low and with the exception of nitrogen, the fertilizer treatments were not effective in raising the yield of the fibre.

Application of nitrogen at both places resulted in a significant ($P < 0.001$) yield increase.

Table III*a*—Yields of Fibre in Tons/ha.—Sangalo

		Ca		K		N		Mean
		0	1	0	1	0	1	
P..	0	1·12	1·27	1·28	1·11	0·98	1·41	1·19
	1	1·39	1·28	1·35	1·33	1·18	1·50	1·34
Ca	0			1·28	1·22	1·03	1·48	1·25
	1			1·34	1·21	1·14	1·42	1·28
K	0					1·08	1·54	1·31
	1					1·08	1·35	1·22
						1·08	1·45	1·27

L.S.D.	5%	1%	0·1%
Between factor means	0·16	0·23	0·32
Between Interactions	0·34	0·46	0·65
Coefficient of Variation	= 17·4%		

Table III*b*—Yields of Fibre in Tons/ha.—Busia

		Ca		K		N		Mean
		0	1	0	1	0	1	
P..	0	1·17	1·21	1·30	1·09	1·07	1·31	1·19
	1	1·10	1·14	1·09	1·15	0·86	1·38	1·12
Ca	0			1·06	1·21	0·93	1·34	1·13
	1			1·33	1·02	1·00	1·35	1·18
K	0					0·96	1·43	1·19
	1					0·97	1·26	1·12
						0·97	1·34	1·15

3.—Finger Millet Trials

Finger millet was an important crop in the province before the development of maize hybrids. With the development of hybrids, many farmers went in for maize and the cultivation of finger millet declined. However, the crop is still extensively grown in the area and it would be of great benefit to the growers if modern production techniques and better crop types were identified.

A number of trials, five in all were planted in the various centres in the province. Three of these, planted at Sangalo, Lumakanda and Busia, compared five varieties, while in two planted at Sangalo and Busia, the effects of Nitrogen, phosphorus and potash on yield of grain were studied.

(a) Variety Trials

The five varieties tested were:— (i) ex-Busia, (ii) Engonyi, (iii) Okiring, (iv) Engoni and (v) ex-Kolanya. The experimental design was a simple randomized block. Table IV is a summary of the trials planted at Busia, Sangalo and Lumakanda.

TABLE IV—FINGER MILLET GRAIN YIELD, Q/HA.

Variety	Busia	Sangalo	Luma-kanda	Mean
Engoni	2·77	11·21	2·16	5·38
ex-Kolanya	2·71	5·53	1·84	3·36
ex-Busia	2·48	7·78	2·51	4·26
Okiring	2·48	7·05	2·38	3·97
Engonyi	2·42	11·36	3·27	5·68
Mean	2·57	8·59	2·43	4·53
L.S.D. 5%	1·23	5·56	1·61	2·80
1%	1·73	7·79	2·26	3·93
Coefficient of variation %	31·26	42·03	42·96	28·75

The high coefficients of variation may be attributed to the great variability to be found in the crop varieties. The general yield levels were low at Busia and Lumakanda. At Sangalo, on the other hand, the yields were high and there was a statistically significant yield difference ($p < 0.05$) between Engoni and Engonyi and ex-Kolanya.

(b) Fertilizer Trials

A 3^3 NPK fertilizer trial was planted at Busia and Sangalo. The rates of N were: 0, 250 and 500 kg/ha of ASN; P was tested at 0, 200 and 400 kg/ha as single superphosphate and Potash as muriate of potash at the rates 0, 120 and 200 kg/ha.

The yield data of the trial planted at Sangalo and presented in Table V show that application of nitrogen resulted in yield decrease, while the effect of phosphate was to increase grain yield. Potash had no effect on yield.

TABLE V—FINGER MILLET GRAIN YIELD, Q/HA.—SANGALO

	N_0	N_1	N_2	K_0	K_1	K_2	Mean
P_0	11·15	8·37	6·78	8·50	9·12	8·68	8·77
P_1	12·09	11·45	10·02	11·02	11·45	10·90	11·19
P_2	14·35	12·12	9·87	11·58	12·37	12·39	12·12
K_0	12·37	9·37	9·55				10·44
K_1	12·50	12·09	8·35				10·99
K_2	12·72	10·48	8·77				10·66
Mean	12·54	10·65	8·90				

L.S.D.	5%	1%	0·1%
Main effects	2·01	2·70	3·57
Interaction effects	5·07	4·64	6·13
Coefficient of variation	= 27%		

The results of the Busia trial like those of the Variety Trial were disappointingly low, the mean yield being only 1.02 q/ha. There were no significant differences among fertilizer treatments.

4.—Groundnut Trials

Three types of groundnut trials were planted. These were, one each of variety; fertilizer and variety/spacing trial.

(a) Groundnut Variety Trials

Twelve varieties i.e. A—Makulu Red, B—Bukene, C—Serere 710, D—Asiriye-Mwitunde, E—Homa Bay, F—Manipintar, G—Natal common, H—Texas Peanut, I—Serere 116, J—Nganda, K—Kaka 781, L—Red valencia were tested at three locations, namely:— Busia, Sangalo and Bondo. The spacing used was 45 cm × 10 cm; and the design was simple randomized block. The varieties were deliberately separated out in three blocks depending on their performance as obtained from earlier trials. Table VI is a summary of the results.

Groundnut Variety Trial results

Table VI—Yield of Shelled Dry and Clean Nuts in Q/ha.

Variety	Busia	Sangalo	Bondo	Mean
Makulu Red	13·13	25·86	11·75	16·19
Manipintar	12·85	25·48	13·20	17·17
Kak 781	12·30	24·82	10·67	15·93
Natal Common	9·81	10·90	8·37	9·69
Asirey Mwitunde	9·74	17·83	7·26	11·61
Serere 116	9·50	11·92	6·91	9·45
Red Valencia	9·40	16·17	7·28	10·95
Bukene	8·48	16·15	7·66	10·76
Texas Peanut	8·18	21·01	6·90	12·03
Nganda	6·76	16·93	7·45	10·38
Homa Bay	5·81	21·36	4·15	10·44
Serere 710	5·48	18·59	7·70	10·59
Mean	9·29	18·92	8·04	12·08
Coefficient of variation	36·5%	12·03%	28·2%	25·58%
L.S.D. 5%	5·74	3·86	3·84	4·48%
1%	7·80	5·26	5·22	6·09
0·1%	10·50	7·07	6·98	8·18

From Table VI it is evident that the varieties differed greatly in their yield performance. At Busia, Makulu Red outyielded Nganda, Homa Bay and Serere 710, ($p < 0.05$), while at Sangalo it was significantly better than Serere 710, Asiriye-Mwitunde, Nganda, Bukene, Red valencia, Serere 116 (white valencia) and Natal common at 1 per cent level and better than Homa Bay, Texas Peanut at 5 per cent level. At Bondo, on the other hand, Manipintar was the best. On the average, the highest yielder at three locations was Manipintar followed by Makulu Red, with Kak. 781 in the third place. The Sangalo trial had the highest and very good yields.

(b) Groundnut Fertilizer Trials (Nitrogen, Phosphorus and Calcium)

A 3^3 factorial trial was planted at four sites, Kakamega, Busia, Sangalo and Bondo.

The fertilizer treatments were:—

Nitrogen	N_0	Nil
	N_1	180 kg/ha. of Amonium Sul. Nitrate
	N_2	360 kg/ha. of Amonium Sul. Nitrate
Phosphorous	P_0	Nil
	P_1	125 kg/ha. of Double supers
	P_2	250 kg/ha. of Double supers
Calcium	Ca	Nil
	Ca_1	500 kg/ha. of Agricultural lime
	Ca_2	1,000 kg/ha. of Agricultural lime

The results of trials are summarized in Tables VII-IX.

TABLE VII—YIELDS IN Q/HA. OF CLEAN SHELLED NUTS—SANGALO

	N_0	N_1	N_2	Ca_0	Ca_1	Ca_2	Mean
P_0	19·41	20·71	19·22	17·09	21·91	20·33	19·77
P_1	19·95	19·67	18·13	17·83	19·06	20·85	19·24
P_2	21·24	20·02	20·89	20·18	21·24	20·72	20·71
Ca_0	17·95	17·95	19·22				18·36
Ca_1	20·43	21·89	19·89				20·73
Ca_2	22·22	20·55	19·13				20·63
Mean	20·19	20·12	19·40				19·91

Coefficient of variation = 15·79%

TABLE VIII—YIELDS IN Q/HA. OF CLEAN SHELLED NUTS—BUSIA

	N_0	N_1	N_2	Ca_0	Ca_1	Ca_2	Mean
P_0	8·02	7·78	6·96	7·37	7·68	7·68	7·58
P_1	9·22	8·09	9·13	9·83	8·46	8·15	8·81
P_2	8·65	9·17	8·32	9·07	8·83	8·22	8·71
Ca_0	8·32	9·17	8·82				8·77
Ca_1	8·37	8·20	8·41				8·32
Ca_2	9·20	7·67	7·18				8·01
Mean	8·63	8·34	8·13				

S.E. for 1 plot (34 df) = 1·84 q/ha.
S.E. of the difference between factor means = 0·612 q/ha.
S.E. of the difference between interaction means = 1·060 q.
Coefficient of variation = 21·93%

TABLE IX—YIELD IN Q/HA. OF CLEAN SHELLED NUTS—KAKAMEGA

	N_0	N_1	N_2	Ca_0	Ca_1	Ca_2	Mean
P_0	12·79	14·08	13·72	13·72	13·93	12·95	13·52
P_1	13·41	12·95	11·35	11·55	12·95	13·20	12·56
P_2	13·31	12·69	12·07	13·38	12·43	13·25	12·68
Ca_0	12·48	12·74	12·43				12·54
Ca_1	13·46	14·18	11·66				13·09
Ca_2	13·81	12·79	12·05				13·13
Mean	13·16	13·24	12·37				12·92

S.E. of plot = 1·60 q/ha.
S.E. of the difference between two factor means = 0·535 q/ha.
S.E. of the difference between two interaction means 0·926 q/ha.
Coefficient of variation = 12·41%.

There were no significant differences between fertilizer treatments at the three sites for which the data were available. The trial at Bondo was damaged by wild animals, particularly squirrels and had to be abandoned. The average yields for Kakamega and Busia were low despite good management practices.

(c) Groundnut Variety/Spacing Trial

A variety/spacing trial was planted at Sangalo and Busia. The spacing treatments were 5 cm, 10 cm and 15 cm within rows and 45 cm and 65 cm between rows. Manipintar and Bukene varieties were used at Sangalo while Homa Bay and Serere 710 varieties were tested at Busia. The treatments were randomized in 3 blocks at Busia and 4 blocks at Sangalo. The yield data for the trial at the two sites are summarized in Table X.

TABLE X—GROUNDNUTS YIELD IN Q/HA (SELECTED DRY SHELLED NUTS)

Location		45cm. between rows			60cm. between rows			Means
	Spacing within rows	5cm.	10cm.	15cm.	5cm.	10cm.	15cm.	
SANGALO	Manipintar Variety	16·27	14·22	11·93	13·04	7·59	10·16	10·40
	Bukene Variety	16·46	14·66	11·91	11·95	12·84	12·08	9·99
Site Sub. mean		16·36	14·44	11·92	12·50	15·22	11·12	10·19
BUSIA	Homa Bay Variety	6·00	6·43	5·91	4·68	5·40	4·24	5·44
	Serere 710 Variety	8·92	12·61	8·19	7·96	8·93	8·62	9·20
Site Sub. mean		7·46	9·52	7·05	6·32	7·12	6·43	7·32
Means for within row spacing		11·91	11·98	9·48	9·81	11·17	8·77	
Between row spacing mean			11·18			9·92		8·74

Within Row Yields in Q/ha.
Spacing

5cm.	—	10·86
10cm.		11·57
15cm.	—	9·12

L.S.D.	SANGALO		BUSIA	
	Varieties	Spacing	Varieties	Spacing
5%	0·60	3·13	4·58	3·10
1%	0·86	4·33	6·42	4·40

The yields at Sangalo were generally higher than at Busia; and while there were differences in yield due to variety, these were not significant. At Sangalo the overall average results show that a spacing of 45 cm × 5 cm gave by far the highest yield. The difference between this and the other spacings was significant, ($p < 0.01$). For Manipintar, the highest yields were obtained when a spacing of 60 cm × 10 cm was used.

At Busia, on the other hand, 45 cm × 10 cm appears to be the best spacing in particular for Serere 710. This spacing is, however, not significantly better than the others.

5.—DWARF BEAN TRIALS

(a) Bean Variety Trials

Varieties tested were: Mexican 142, Uganda 47, 141, 35, Niacol Nima No. 73, Kabamima Sel. No. 74, Kabanyolo Selections, Nos. 127, 153, Rose coco and Canadian wonder. The trial was laid down as simple randomized blocks with 4 blocks being used at each of the sites i.e. Kimilili, Sangalo and Lumakanda. The object of the trial was to determine the best yielding variety.

TABLE XI—BEAN YIELD IN Q/HA.

Variety	Kimilili	Lumakanda	Sangalo	Kakamega
A—Mex. 142	7·59	5·95	4·70	9·84
E—Uganda 47	7·04	4·54	2·51	5·38
J—Kabanyolo Se.	5·49	8·52	2·21	8·07
F—Uganda 141	5·40	6·83	2·03	7·56
B—Rose coco	4·44	5·67	2·02	2·04
G—Niacol Nima No. 77 ..	4·38	9·86	3·02	10·21
D—Uganda 35	4·32	3·94	2·48	3·50
H—Kabamima Sel. No. 74 ..	3·38	9·77	2·51	6·68
I—Kabanyolo Sel. No. 153 ..	3·30	5·60	2·05	2·20
C—Canadian Wonder	2·10	4·05	1·77	4·32
Mean	4·79	6·47	2·54	5·98
Coefficient of variation	26·7%	42·8%	25·17	32·78
L.S.D. 5%	1·85	4·00	0·92	3·00
1%	2·50	5·40	1·25	4·05
0·1%	3·33	7·20	1·66	5·39

The average yields were low, particularly at Sangalo. Those obtained at Lumakanda and Kakamega approached the expected yields with the average level of management. The low yields point to the importance of improving the quality of planting material and also determination of agronomic factors limiting bean yields.

(b) Time of Planting Trials

The object of the trials was to find out the effect of varying the time of planting on bean yields. The treatments i.e. time of planting, chosen were: A—4th of August, B—18th of August, C—1st of September, D—15th of September, E—29th of September, 1970. These were laid out in randomized blocks. The series were planted at Sangalo, Kakamega and Maseno. That at the former place was damaged by hail and had to be abandoned. Those at Kakamega and Maseno were successfully harvested and results are presented in Tables XII and XIII.

TABLE XII—TIME OF PLANTING YIELD CLEAN SEED MEXICAN, 142, KG./HA.
KAKAMEGA

Dates of Planting	*Yield*
4–8–70	921
18–8–70	1,512
1–9–70	949
15–9–70	513
29–9–70	173
Coefficient of variation	16·58%
L.S.D. (5%)	209

The data show that planting after September results in yield decrease. After September, the short rains season sets in and conditions tend to be drier—(see Table I for rainfall data). While the yields obtained were low compared to what is commercially desirable, the results indicate that ideally beans should be planted soon after the end of long rains before the dry spell has had its effects.

TABLE XIII—YIELD CLEAN SEED, MEXICAN 142, IN KG/HA.—MASENO

Dates of Planting	*Yield*
4–8–70	667
18–8–70	667
1–9–70	566
15–9–70	531
29–9–70	117
L.S.D.	259 kg/ha.
Coefficient of variation	33·02%

The general yield level was much poorer than at Kakamega. Again late planting, with reference to the setting in of short rains gave the lowest grain yields. Despite small differences in yield between August (early) and September planting, it should be noted that the time of planting might not have been the critical limiting factor in this particular trial. This is so because the yield level is low in comparison with the trial at Kakamega.

6.—BANANA SPACING/PRUNING TRIAL

The spacing treatments were, S_0—3.05 × 1.83 m, S_1—3.05 by 2.44 m and S_2—3.05 × 3.56 m; and the pruning treatments were P_0—3 suckers per stool, P_1—5 suckers per stool and P_2—7 suckers per stool. The trial was laid down in a 3^2 factorial design. Table XIV is the summary of the results.

TABLE XIV—YIELDS OF FRESH FRUITS IN TONS/HA.—KAKAMEGA

Spacing/Pruning	S_0	S_1	S_2	Mean
P_0	28·16	29·12	44·00	33·76
P_1	35·19	44·13	37·60	38·97
P_2	28·16	41·16	41·95	37·09
Mean	30·50	38·14	41·18	36·60

Coefficient of variation = 12·7%

The mean yields were lower than in 1969 presumably due to the ageing of the plantation. The trial was, therefore, discontinued at the end of 1970.

J. B. S. MAKATIANI,*
Agricultural Research Officer-in-Charge.

*Mr. Wamalwa, Officer-in-Charge of the station was transferred in January, 1971, to the Seed Certification Unit, Nakuru, and was succeeded by Mr. Makatiani who compiled the report.

NYANZA AGRICULTURAL RESEARCH STATION, KISII

A.—Review for the Year

A total rainfall of 2456.6 mm was received at the station. This was much higher than the annual average of 1943.4 mm. As shown in Table 1, the rainfall was well distributed throughout the year. This resulted in good pastures and crops. Maize planted both in the long and short rains gave good yields.

TABLE 1—RAINFALL DATA IN MM.—KISII

	Amount	Days
January	113·0	13
February	109·4	10
March	409·6	23
April	248·2	28
May	216·4	21
June	174·8	15
July	106·2	13
August	206·6	23
September	144·2	19
October	89·3	11
November	151·2	14
December	487·1	15
TOTAL	2,456·6	205

B.—Report on Experiments

1.—MAIZE EXPERIMENTS

Time of planting trial was planted on the main station and at Oyani. Planting dates were split for fertilizer application. There were 8 treatments planted at 2 weekly intervals in the experiment at Kisii and 10-day interval in the trial at Oyani. Subplots which received fertilizer had 500 kg/ha single superphosphate at planting and 250 kg/ha A.S.N. at knee high. The results are presented in Tables II and III for Kisii and Oyani sites respectively.

TABLE II—MEAN GRAIN YIELDS, BAGS/HA. (1 BAG = 90 KG)—KISII

Date of planting fertilizer	3/1	17/1	31/1	13/2	27/2	13/3	27/3	10/4	Fertilizer Mean
With fertilizer ..	65·8	82·3	83·7 (3)+9·8	58·5	72·7 (4)+11·7	82·7	58·1	26·1	65·6 (1)+3·5
Without fertilizer	52·6	74·1	96·0	63·6	50·3	64·5	44·8	25·1	58·9
Treatment Mean	59·2	78·2	89·8 (2)+9·5	58·5	61·5	73·6	51·4	25·6	62·3

L.S.D.	P	0·05	0·01
	(1)	7·4	10·1
	(2)	20·3	28·1
	(3)	20·8	28·7
	(4)	24·8	34·2

TABLE III—MEAN GRAIN YIELDS, BAGS/HA—OYANI

Date of planting fertilizer	1·3	13/3	23/3	2/4	11/4	23/4	Fertilizer Mean
With fertilizer ..	70·0	87·8	64·9	63·1	53·5 (4)+11·7	41·2	63·4 (1)+3·5
Without fertilizer ..	67·7	64·9	(3) 50·8	49·4	41·2	26·6	50·0
	68·8	76·4	57·8 (2)+9·4	56·2	47·3	33·8	56·7

NOTE—Treatments 7 and 8 were heavily damaged by pests and were therefore discarded.

L.S.D.	P = 0·05	P = 0·01
(1)	7·4	10·2
(2)	19·9	27·4
(3)	20·8	28·6
(4)	24·8	34·2

The mean yields at the two sites were high. This may be attributed to good and well distributed rainfall. Despite the general level of yield being high, it is evident that there is a general decline in yield with delay. This is particularly so when fertilizer is not applied.

The low yields obtained in the first treatment may be due to the dry spell at the time the treatment was planted. For although the rains had set in there was not enough moisture in the soil. Also it has been noticed that both early and late planted crops suffer from birds' damage. At Kisii the application of fertilizer increased yield appreciably but the increase did not attain statistical significance (P=0.05). At Oyani, use of fertilizer has significantly (P=0.01) increased grain yields.

2.—SOYA BEANS

(a) A soya bean variety trial testing 7 varieties was planted at Oyani (S. Nyanza); Seme (Kisumu District); Kolwa (Kisumu District) and Keroka (Kisii). The object of the trial was to select out the better yielding varieties for further improvement. The trial was laid down as a 7 × 7 Latin square. (The seed was inoculated prior to planting). Results of the trial are given in Table 4.

TABLE 4—SOYA BEAN GRAIN YIELD. KG/HA

Treatment	Oyani	Seme	Kolwa	Keroka
Hill	1,716·2	1,635·9	1,052·5	823·8
B. Congo	1,380·3	1,553·3	965·4	719·9
Dorman	1,118·1	1,148·6	1,107·4	419·2
Clark	891·2	1,117·3	927·7	446·6
A–100	842·3	958·8	971·3	222·2
Kent	753·1	1,209·9	637·1	372·0
Delma	381·9	1,198·1	889·9	409·2
Mean	1,011·9	1,260·3	935·9	487·6
Coefficient of variation	*per cent* 28·8	*per cent* 18·4	*per cent* 41·2	*per cent* 21·7
L.S.D.—5 per cent	596·1	253·3	421·2	115·4
1 per cent	802·7	341·1	567·7	155·5

From the data in Table 4 it is seen that the general yield level was very low at Keroka, only fair at Kolwa and good at Oyani and Seme. It must be noted that because of the distance between Kolwa and the main station, supervision at the former station was poor, hence high level of variability as evidenced by the coefficient of variation.

Except at Kolwa, "Hill" gave the highest yield. It was, however, not significantly better than B. Congo at all the sites.

(b) Soya bean variety/fertilizer trial

In the second soya bean trial a study was made on the performance of the seven varieties under 4 different levels of single superphosphate (21 per cent P_2O_5) in a split-plot design. There were 3 replications of main treatments in randomized complete blocks. The phosphate was applied at planting. The seed was inoculated just before planting. Table 5 is a summary of the results.

TABLE 5—SOYA BEAN GRAIN YIELD, TONS/ha.

Fertilizer variety	0 Kg/ha	125 Kg/ha	250 Kg/ha	500 Kg/ha	Mean
Hill	1·7	1·7	1·6	1·5	1·6
B. Congo	2·1	2·1	1·7	2·8	2·2
Dorman	1·9	2·2	1·9	1·7	1·9
Delman	2·2	2·2	1·9	2·2	2·1
A–100	2·4	2·0	1·3	2·2	2·0
Clerk	1·8	2·2	2·2	1·8	2·0
Kent	1·1	1·6	1·3	1·2	1·3
Mean	1·9	2·0	1·7	1·9	1·9
	per cent				
Coefficient of variation ..	3·4				

The data in Table 5 shows that application of phosphate had no effect on yield. Compared with the first trial, i.e. variety trial, it is seen that the yield level was high. Unfortunately soil tests were not carried out to determine the fertility level of the trial sites.

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*Mr. S. W. Awili-Jandara was Officer-in-Charge up to January 1971 when he was transferred to N.A.R.S. Kitale and was succeeded by Mr. Mbagaya who compiled the Report.

KATUMANI AGRICULTURAL RESEARCH STATION, MACHAKOS

A.—Weather

The Long Rains (L.R.) at Katumani commenced in the last week of March and continued through to May. At Kampi-ya-Mawe, the L.R. started much earlier than at Katumani, i.e. 17th February. The total rainfall during the L.R. season at the two centres was 323.7 mm for Katumani and 247.0 mm for Kampi-ya-Mawe. Although the seasonal rainfall total for Katumani was below average, it was fairly well distributed. The evenly distributed rainfall resulted in high yields for crops grown during the season. On the other hand the Short Rains (S.R.) were not only too brief but also so erratically distributed that crops could not be raised during the season.

The annual rainfall totals i.e. 560.2 mm for Katumani and 545.8 mm for Kampi-ya-Mawe given in Table I were considerably lower than the 14 years means of 730.1 mm and 712.2 mm respectively.

TABLE I—RAINFALL DISTRIBUTION AT KATUMANI AND KAMPI-YA-MAWE, 1970

MONTHS	KATUMANI		KAMPI YA MAWE	
	Number of days	Amount mm	Number of days	Amount mm.
January	7	135·8	5	34·7
February	—	0·0	9	88·2
March	5	101·9	15	90·4
April	10	137·0	4	35·6
May	7	84·8	3	32·8
June	1	1·0	1	4·3
July	1	1·6	—	0·0
August	1	4·3	1	15·0
September	—	0·0	0	0·0
October	—	0·0	7	28·4
November	8	34·0	19	184·7
December	4	59·8	8	31·7
TOTAL	44	560·2	72	545·8

B.—Reports on Experiments

1.—TIME OF PLANTING AND WEEDING TRIAL FOR MAIZE AND MEXICAN 142 BEANS

A 4×4 factorial trial was planted at the main station.

The 4 times of planting treatments were:—

T_0—Dry planting

T_1—Planting 7 days after onset of rains

T_2—Planting 14 days after onset of rains

T_3—Planting 21 days after onset of rains

Seven days after the rains, the fields were still clean enough to plant without cultivation, but weeds had already germinated. For T_2 and T_3 fields were cultivated before planting since there was a large amount of weeds covering the ground.

The weed control treatments were:—

W_0—Control no weeding.

W_1—Clean weeding the first three weeks from crop emergence.

W_2—Clean weeding starting 3 weeks after crop emergence and continues to end of season.

W_3—Clean weed throughout crop season.

Maize

The results of the experiment with maize are summarized in Table 2. From these it is seen that the maize grain (economic yield) responded to time of planting better than the total crop dry matter (biological) yield. Dry planted maize gave the highest grain and total crop dry matter yield. This crop benefited from the early rain and had uniform germination. The late planted maize had poor germination rate which may be attributed to wet conditions after planting.

The weeded treatments W_1, W_2 and W_3 were not significantly different and were better than the unweeded treatment.

TABLE II—GRAIN (ECONOMIC) YIELD OF MAIZE Q/HA

Time of Planting	Weeds				Means
	W_0	W_1	W_2	W_3	
T_0	9·4	45·4	43·9	50·8	37·4
T_1	0·8	35·1	13·7	40·9	22·6
T_2	17·4	38·7	42·0	45·8	36·0
T_3	8·2	34·8	28·7	27·7	24·9
Means	8·9	38·5	32·1	41·3	30·2
L.S.D. p = ..	5%	1%	0·1%		
Time of planting..	2·9	4·3	7·0		
Weeds	4·6	6·2	8·1		
Interaction ..	13·1	17·6	23·1		

The results further show the importance of early planting and clean weeding throughout the crop season. The early planted and clean weeded maize gave a yield of 50.8 q/ha as against 9.4 q/ha in the case of early planted but unweeded crop; a difference of over 40 q/ha.

Crop index, which has been defined as grain yield × 100 and divided by total dry matter yield, not shown in Table 2, was poorly correlated with grain yield. The early planted maize showed a crop index of 34.2 per cent but good yield per unit area and late planted maize 38.6 per cent but poor yield per unit area. During the ear filling period there was no water and mineral stress on late planted maize had much less cloud cover than the early planted maize. Thus late planted maize had adequate assimilate for the sinks.

Weeds did not show response to time of planting, because the fields had to be weeded for late planting. Thus, where maize competes for labour with other crops, clean weed the first three weeks after crop emergence can be economically feasible.

Beans

The response to time of planting and weeding treatment were just the same as in maize. See Table 3 below:—

TABLE III—GRAIN YIELD OF BEANS Q/HA

Time of planting	Weeds				Means
	W_0	W_1	W_2	W_3	
T_0	17·5	31·4	30·1	36·1	28·8
T_1	13·5	26·3	27·5	26·7	23·5
T_2	6·8	13·3	14·4	13·9	11·9
T_3	10·3	17·9	16·7	17·5	15·6
Means	12·0	22·2	22·2	23·4	19·9
L.S.D.	5%	1%	0·1%		
Time of planting ..	6·5	9·9	15·9		
Weeds	1·9	2·5	3·3		
Interaction	5·8	7·8	10·3		

The mean crop index was low and showed little response to time of planting. Weeds did not affect the crop index according to F test which was not significant.

There was no significant response to weed infestation because of the spreading nature of beans smothering germinating weeds.

Dry planting and clean weeding throughout the crop season or clean-weeded the first three weeks after crop emergence gave same results.

2.—Maize and Mexican 142 Bean Population and Weeding Trial

Treatments	Spacing	Plants/acre	Plants/Hectare
P_0	75×60 cm	8,997	22,222
P_1	75×40 cm	13,495	33,333
P_2	75×30 cm	17,993	44,444
P_3	75×20 cm	26,990	66,667
Beans			
P_0	50×30 cm	26,990	66,667
P_1	50×20 cm	40,486	100,000
P_2	50×15 cm	53,981	133,333
P_3	50×10 cm	80,972	200,000

The weed treatments were:—

W_0—Control—no weeding at all.

W_1—Clean weed in the first three weeks after crop emergence only.

W_2—Clean weed to start at three weeks after emergence and to continue to harvest.

W_3—Clean weed throughout.

Maize

Plant population had no significant effect on the grain and total crop dry matter yield. This may be attributed to the excellent rainfall distribution throughout the crop season, and the genetic potential of Katumani maize.

The mean grain yield of 30.2 q/ha was good and comparable to other trials, *see* Table 4.

Table IV—Mean Grain Yield of Maize q/ha

Population	Weeds				Means
	W_0	W_1	W_2	W_3	
P_0	6·8	32·8	37·2	42·6	29·8
P_1	9·1	37·9	38·3	41·3	31·5
P_2	11·2	35·6	38·3	40·3	31·3
P_3	11·7	29·8	35·5	35·9	28·2
Means	9·7	34·0	37·1	40·0	30·2

L.S.D.	5%	1%	0·1%
Populations	5·2	7·9	12·7
Weeds	3·1	4·1	5·4
Interaction	8·8	11·8	15·5

Response to weeds as seen in Table 4 is strange for clean weed to start at three weeks after emergence and continue to harvest compares well with clean weed throughout. This phenomenon is mainly due to the ideal climatic conditions which prevailed during the season. For economic reasons clean weed in the first three weeks after crops emergence is recommendable.

Crops index mean of 33.1 per cent changed little with higher plant population. This can be argued that competition between plants was high in the higher population than in the lower ones. Thus, the assimilates in the higher populations were inadequate for the sinks (roots and vegetable growth).

Higher plant populations reduced the yields of weeds due to shading effect of the developed crop canopies.

Beans

The grain yield and the total crop dry matter yield increased as population increased. Same reason given for maize yields apply to beans also.

TABLE V—GRAIN YIELDS OF BEANS IN Q/HA

Populations	Weeds				Means
	W_0	W_1	W_2	W_3	
P_0	7·7	22·5	17·1	23·0	17·6
P_1	10·6	30·2	21·7	20·5	23·0
P_2	9·6	27·0	20·7	29·2	21·6
P_3	12·9	28·9	22·3	30·0	23·5
Means	10·2	27·2	20·5	28·0	21·4
L.S.D.	5%	1%	0·1%		
Population	3·2	4·9	7·9		
Weeds	2·2	3·0	3·9		

Clean weed the first three weeks from emergence is recommended.

Crop Index of beans was high at 61.2 per cent but decreased as population increased.

The results above show no response to population which confirms 1969 results. Last year's plant population ranged from 83,334 pl/ha to 66,667 pl/ha and this year from 66,667 pl/ha to 200,000 pl/ha.

Irrigation trials on Maize and Mexican 142 *Beans*

Irrigation Treatments

1. Irrigation
2. Non-Irrigation

Weed Treatment

W_0—Control of weeding at all.

W_1—Clean weed in the first three weeks after emergence only.

W_2—Clean weed to start at three weeks after emergence and to continue to harvest.

W_3—Clean weed throughout.

Maize

The mean grain yield did not show any difference between irrigated treatments and non-irrigated treatments. However, irrigation increased significantly the total crop dry matter over none irrigated treatments. (*See* Tables VI and VII.)

TABLE VI—GRAIN YIELD IN Q/HA OF MAIZE

	Weeds				Means
	W_0	W_1	W_2	W_3	
Non-Irrigation ..	13·1	29·7	25·7	29·4	24·5
Irrigation ..	8·4	26·5	21·2	26·2	20·6
Means	10·8	28·1	23·4	27·8	22·5

	5%	1%	0·1%
L.S.D.			
Weeds	6·4	10·0	17·0

The crop index of 58.7 per cent was high and uniform and there was no response to irrigation. Weeded treatments did not show any significant difference, except the unweeded treatment.

Fertilizer Effect on Maize and Mexican 142 Beans

Fertilizer Treatments

F_0—No fertilizer.

F_1—120 Kg/ha double supers.

120 Kg/ha A.S.N.

TABLE VII—GRAIN YIELD IN Q/HA OF MAIZE

	Weeds				Means
	W_0	W_1	W_2	W_3	
Non-Irrigation ..	14·9	43·3	32·5	48·0	34·7
Irrigation ..	18·4	43·8	32·9	43·7	34·7
Means	16·6	43·5	32·7	45·8	34·7

	5%	1%	0·1%
L.S.D.			
Weeds	5·1	8·1	13·7
Fertilizers	4·8	6·7	9·6

Clean weed in the first three weeks after crop emergence gave same results as clean weed throughout.

Crop Index of 39.2 per cent was fairly high and irrigation only slightly lowered it. Crop Index was not affected by weeds. Both maize and weeds benefited from the extra moisture.

Beans

The mean grain yield was the best for Katumani. The crop dry matter production was good. Both did not show any response to irrigation.

Weed treatments

W_0—Control—no weeding at all.

W_1—Clean weed in the first three weeks after emergence only.

W_2—Clean weed to start at three weeks after emergence and to continue to harvest.

W_3—Clean weed throughout.

Maize

The grain yield and total crop dry matter yields were highly increased by fertilizer application as compared to no fertilizer application treatment. A more detailed fertilizer investigation at several rates will be carried out in areas growing Katumani maize in 1971.

TABLE VIII—GRAIN YIELD OF MAIZE IN Q/HA

Fertilizer	Weeds				Means
	W_0	W_1	W_2	W_3	
F_0	4·9	31·2	19·7	35·4	22·8
F_1	28·4	55·8	45·7	56·2	46·5
Means	16·6	43·5	32·7	45·8	34·6

Crop index did not show response to fertilizers. The weeded treatments were not significantly different, except the control unweeded treatments, which adversely affected the yields.

Beans

A total crop dry matter responded much more than grain yield to fertilizer treatment.

TABLE IX—GRAIN YIELD OF BEANS IN Q/HA

Fertilizer	Weeds				Means
	W_0	W_1	W_2	W_3	
F_0	11·1	28·8	22·9	42·1	21·7
F_1 120 Kg/ha double supers 120 Kg/ha A.S.N. ..	10·4	27·4	22·9	31·5	23·0
Means	10·7	28·1	22·9	27·8	22·3

Crop index was reduced significantly in the fertilizer treatment, but did not affect the weed dry matter, clean weed in the first three weeks after crop emergence gave same results as clean weed throughout.

Methods and Periods of Weed Removal for Maize

Treatment

(i) *Methods*

(*a*) Jembe hoeing.

(*b*) Pulling of weeds substituted by panga weeding.

(*c*) Scaping using a Dutch hoe.

(*d*) Herbicide.

(ii) *Periods*

W_0—Clean weed the first four weeks after emergence.

W_1—Clean weed to start at end of fourth week after emergence and continue to end of season.

Maize

TABLE X—GRAIN YIELD OF MAIZE IN Q/HA

	Methods of Weed Removal				Means
	A	B	C	D	
W_0	33·1	38·1	33·3	28·9	33·3
W_1	37·8	30·6	26·0	15·3	27·4
Means	35·4	34·3	29·6	22·1	30·4

	5%	%1	0·1%
L.S.D.			
Periods	4·1	5·6	7·5
Methods	5·7	7·8	10·5
Interaction	11·5	15·6	21·0

Order	Treatment	Yield
1.	BW_0	38·1* a
2.	AW_1	37·8 a b
3.	CW_0	33·3 a b c
4.	AW_0	33·3 a b c
5.	BW_1	30·6 a b c
6.	DW_0	28·9 b c
7.	CW_1	26·0 c
8.	DW_1	15·3 d
Mean		30·4

*Means followed by the same letter are not significantly different.

The mean grain yield of 30.4 q/ha compares well with the other trials. Weed removal by jembe hoeing and panga were the same in clean weed the first four weeks after emergence, and gave highest yields. Later weed removal showed a decline in yield. The best means recommended for weed removal is either by jembe hoeing or panga which are also the prevailing cultural methods.

Further investigations in weed control by herbicides will be carried in March Long Rains 1971.

Long Term Crop Rotation

The object of this experiment is to find a suitable crop rotation for the Dry Marginal Areas of Kenya especially in Machakos and Kitui. This experiment was designed as a follow-up of Bennison's work (1968) (3) on some effects of crop rotation on the productivity of crops on a red earth in semi-arid tropical climate. The site has uniform fertility.

TABLE XI—GRAIN YIELD OF SUB-TREATMENTS—FERTILIZERS IN Q/HA

		Phosphate		Manure		Mean
		0	1	0	1	
Nitrogen ..	0	42·24	45·23	39·32	48·15	43·72
	1	48·32	50·37	47·28	51·42	49·33
Mean ..	..	45·27	47·79	43·29	49·77	46·52
Phosphate	0			41·61	48·95	45·27
	1			44·98	50·62	47·79
Mean ..	..			43·29	49·77	46·52

L.S.D.	5%	1%	0·1%
Main Treatment ..	4·85	6·65	9·06
Fertilizer	3·42	4·69	6·39
Interaction	9·71	13·30	18·12

The mean grain yield of 46.52 q/ha of maize grain is very good and coefficient of variation was low at 10 per cent.

Maize showed response to nitrogen and manure at 1 per cent and 0.1 per cent levels respectively. There was no response to phosphates. Inter-cropping of maize and beans reduced the maize grain yields.

Early Maturity Maize Annual Breeding Report

Katumani Composite B

This composite was released on 27th August, 1970 during the Maize Improvement seminar held at Machakos Farmers' Training Centre to replace Katumani Composite A. The released Composite B is pure white, after clearing the yellow colour and shows yield increase of about 5 per cent over Composite A.

Further improvement was carried out by single mass selection of 10 per cent selection intensity on 10,000 plants grown in isolation during March 1970. This gave 1,000 ears which were shelled to form the bulk for the composite seed for the next mass selection in March 1971. This procedure will be continued until such time as synthetic 7 and 8 take over.

Katumani Synthetic VII

Selected S_1 lines evaluation in isolation was started in March 1970. Only 5 clean ears selected on weight, earliness and freedom from yellow colour from 500 lines were kept.

The white seed from the selected ears was bulked with the rest for recombination during the March 1971 season in isolation. This recombined base population will be Katumani Synthetic VII (Co) for S_1 Testing intensive recurrent selection to begin in October 1971.

Katumani Synthetic VIII

Mixing of the components was completed for the fourth generation during the March 1970. Best 5 ears from each of the 84 components were shelled in one physical bulk and grown in 400 rows of 50 plants each from this seed. S_1 evaluation cycle to clear up the colour will start during March 1971.

Katumani Synthetic VII O_2

The last back-crosses were completed in March 1970 on Synthetic VII. 200 rows of 50 plants each of opaque was detasseled and sandwiched in the S_1 lines Synthetic VII. Evaluation trial by random mating in isolation of Synthetic VII—O2 detasseled and sandwiched between VIII O_2 will start in March 1971.

Katumani Synthetic VIII O_2

This was handled in the same procedure as Synthetic VII O_2 above. Evaluation trial by random mating in isolation detasseled and sandwiched between Synthetic VII O_2 will start in March 1971.

Early Maturity Maize Variety Trial

The March 1971 will have 8 entries instead of 7 as planned for 1970 to be grown in the Early Maturity Areas.

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